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DISASTER ASSISTANCE - EARTHQUAKE HAZARD REDUCTION.

NATO Committee on the Challenges of Modern Society
Brussels, Belgium

May 1971

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DISASTER ASSISTANCE

Earthquake Hazard Reduction

N.9

SECOURS EN CAS DE DESASTRES NATURELS

Tremblements de terre

Vol. 2

EXPERIENCE GAINED FROM RECENT EARTHQUAKES IN TURKEY

by Alkut Aytun

INTRODUCTION

During the past five years, Turkey has experienced a number of destructive earthquakes. Each of these earthquakes were faced with an ever increasing interest and effort, both by governmental and technical authorities. Each one occurred in different regions of Turkey, with different climate, different socio-economic conditions, different materials and building types. The analysis of the events caused by those earthquakes, reveals interesting facts of the country, from the point of view of earthquake engineering.

After a comparative study of the mentioned successive earthquakes, one can say that the performance of post-earthquake activities is more and more efficient, than the previous ones. This is explained in the other paper, titled "General Information on Organization and Activities for Earthquake Disaster Response in Turkey".

Although it is possible to learn some facts through literature, the efficiency and certainty, provided by actual experience, can not be substituted. Many of the lessons, taught by those earthquakes, are of value to engineers, professionals and administrative people, though some of them may be repetitions of known facts.

The earthquakes considered are as follows:

Locality	Date	Loss of Life	Dwellings Destroyed
Varto	19.8.1966	2,500	20,000
Adapazari	22.7.1967	86	7,100
Bartin	3.9.1968	26	260
Alasehir	28.3.1969	41	2,500
Gediz	28.3.1970	1,086	15,000

It is not intended to give full information on each earthquake. Only a rough outline will be given, from points of view of settlement and building materials; then general conclusion will be given, following the indication of distinguished features of each earthquake.

VARTO EARTHQUAKE (19.8.1966)

(M = 7, epicentral intensity I_o = IX (MM), epicentral co-ordinates:
39°.2 N - 41°.7 E (U.S.C.G.S.)
39°.2 N - 41°.6 E (B.C.I.S.))

The main shock caused a death toll of 2,500. Although the population density is low (24 per sq.km or 62 per sq. mile), most of the local types of buildings were not earthquake-resistant. The isoseismal map is shown in Figure 1(1). The dominant building material is round stone and adobe. Mud is popular as material for mortar, and generally no cement is used. The buildings have heavy ceilings. Most of the damage was focussed on Varto and Mus. The Regional School, which was of reinforced concrete construction, suffered heavy damage. The existing settlements were preferred and new houses were built generally on the same location. Relief and reconstruction activities were considerably larger in size, comparing the previous activities.

ADAPAZARI EARTHQUAKE (21.7.1967)

(M = 7, epicentral intensity I_o = IX (MM), epicentral co-ordinates:
40°.7 N - 30°.8 E (B.C.I.S.)
40°.7 N - 30°.8 E (U.S.C.G.S.))

The earthquake was accompanied by the activation of a segment of 100 kilometers (60 miles), on the North Anatolian Fault Zone. It lent itself for a clear mapping. The right-handed strike ship and moving down of Northern side, exhibited the known characteristics of the North Anatolian Fault Zone, and once more pointed to the need for systematic study on it.

Adapazari region is in process of development and it is known as one of the richest portions of the country, with agricultural and industrial resources and a suitable climate. Although the ground motion was intensive and the population density was quite high (about 90 per sq.km or 230 per sq. mile), the death toll was only 86, thanks to the type of local construction. The popular construction type is timber frame with brick-fill or timber lath siding. The roof is usually light and of timber construction with tiles.

Lots of landslides were observed. It was noted that the rate of damage was not necessarily too high in the vicinity of the fault zone.

BARTIN EARTHQUAKE (3.9.1968)

(M = 6.5, epicentral intensity I_o = VIII (MM), epicentral co-ordinates:
41°.8 N - 32°.3 E (U.S.C.G.S.)
41°.38 N - 32°.20 E (I.T.U.))

Bartin earthquake caused interest, from the point of view of earthquake zoning. No earthquakes were recorded in the past, and it was considered in the danger-free zone. However, a field study revealed that there were complicated crack systems, pointing out that the region must have experienced earthquakes in the past.

Loss of life was 26, due to local character of the earthquake, (the population density is 75 per sq.km or 195 per sq. mile).

It was observed that a 4 km (2.5 miles) portion of the shore line was uplifted by 40 cm (1' 1/3 approximately) in the middle, gradually decreasing to the ends. The terraces at several heights by the sea, show that there have been continuous uplifting on the Black Sea coast.

Masonry is dominant in the region, but it is not good from earthquake engineering view.

ALASEHIR EARTHQUAKE (28.3.1969)

(M = 5.5, epicentral intensity I_o= VII (MM), epicentral co-ordinates:
38°.3 N - 28°.6 E (macro))

The earthquake was associated with vertical movements. The area is well known from the point of agriculture (grape, fig, tobacco, cotton etc.). The area of damage is within a valley in east-west direction. Soil conditions are very poor in the central part. The town Alasehir exhibits different characters of soil, from the lower part of the valley, towards the higher slopes.

The dominant building type is masonry. Generally stone and adobe is used with mud mortar. Ceiling is covered with raw timber, and earth is put on the top, to provide insulation. As it is heavy, it is not good from earthquake engineering point. Though 41 lives were lost in the earthquake. The population density in the area is 55 per sq.km (or 145 per sq. mile).

Minor relocations were decided, and prefabricated housing is extensively applied after Bartin and Alasehir earthquakes.

GEDIZ EARTHQUAKE (28.3.1970)

(M = 7, epicentral intensity I_0= IX (MM), epicentral co-ordinates;
39°.1 N - 29°.4 E (macro)
39°.0 N - 29°.3 E (U.S.C.G.S.)
39°.1 N - 29°.6 E (B.C.I.S.))

Much of the effect was felt in Gediz and surroundings. The town rests on a portion of Gediz River Valley. Loss of life is 1,086. The population density is about 35 per sq. km (or 91 per sq. mile). Great fires in Akcaalan and in some districts of Gediz, increased the death toll and loss of property. As may be understood, timber framed buildings are popular. Masonry and reinforced concrete buildings are also met in comparably small numbers.

The location of Gediz town was changed, and microzoning studies were conducted in the new settlement. Reconstruction was completed within four months.

Relation of damage and soil conditions were studied by Earthquake Research Institute of the Ministry of Reconstruction and Resettlement.

One of the distinguished features of Gediz earthquake, is the high interest of governmental and educational institutions.

GENERAL CONCLUSIONS

The experience from the mentioned 5 earthquakes, as representative of the general earthquake picture of Turkey, provide conclusions applicable to the whole country. The most important conclusions are as follows:

- Earthquake resistance of local building types
- Effect of soil on damage,
- Effect of earthquake on reinforced concrete structures
- General

EARTHQUAKE RESISTANCE OF LOCAL BUILDING TYPES

Local buildings can roughly be divided into two groups, with sub-divisions as follows:

(a) Timber frame buildings (brick-fill type; wood lath siding type; massive wood type).

(b) Masonry type (field stone type, hewn stone type, brick, adobe and concrete block types).

TIMBER FRAME AND WOOD-LATH SIDING TYPE BUILDINGS

In the affected areas (e.g. in Akçaalan at Gediz area, and lots of examples from Adapazari area), numerous standing or at most slightly damaged buildings make the observers surprised, who see many destroyed ones around. These are two or three storeyed timber framed and wood lath siding type buildings. The load bearing system is composed of timber columns, beams and diagonals. They are connected together by nails, and wooden laths are nailed to form both inner and outer wall surfaces. The space between the sidings, is sometimes filled with loose material for insulation, or left empty. The sidings are covered by plaster. Use of nailed connections in great extent, increases the ductility. It is well known that ductility is a greatly desired quality in earthquake engineering to absorb energy, transferred to the building. In addition, wood laths prevent the filling material from falling down. This decreases loss of life and keeps the form of walls even under great displacements. In some cases, ground floor of masonry type collapsed, but the upper floor of this type came down without much deformation and damage in itself.

The common defect in this type of building is the connections, where inadequate details are used, and number of nails are less than required.

TIMBER FRAME AND BRICK-FILL TYPE BUILDINGS

Although it has the merits of the former type, falling of filling blocks can cause loss of life and extensive deformation. Ductility is less than that of the former type. Wire mesh prevents falling of the filling blocks to some extent. This type is opposed by some engineers, stating that two building materials (timber and masonry) with quite different dynamical characteristics, are brought together. In case of a serious movement, the plaster cracks are formed on the joints between timber and masonry block.

FIELD STONE TYPE BUILDING

These types of buildings are in great number in Varto. Mud mortar or nothing is used to joint the stones. Usually the ceiling is heavy, a thick layer of earth for insulation, is carried by raw timber beams. Evidently there is no resistance against earthquakes. The loss of life is heavy.

HEWN STONE, BRICK AND CONCRETE BLOCK TYPE BUILDINGS

Though slightly better than the former type, the ductility and resistance is not sufficient. A reinforced concrete slab of adequate thickness and reinforcement, provides connection between walls, resulting in greater strength. As this type is well known in other countries, only the earthquake aspects will be discussed. Although there are some measures to increase the earthquake resistance of masonry buildings (e.g. providing close tie beams, to provide solid wall blocks of adequate dimensions between window or door openings, utilization of high cement mortar, etc.) the past experience shows that this type of building can be easily damaged in serious earthquakes. In Japan, for example, this type is completely forbidden. As the material behaves in the brittle way, not much resistance is expected.

The following factors increase the vulnerability of this type of building:

1. Utilization of mud or lime mortar, instead of cement mortar.

2. Brickwork, without wetting the bricks. In this case the dry brick absorbs the water of the mortar and the hydratation of the cement is not complete. Consequently the sheer resistance of the wall is rather low.

3. Poor connections of the tie beams in the corners.

4. Poor design of roof, allowing the members transferring horizontal forces to walls, resulted from vertical loads.

ADOBE BUILDINGS

Adobe is locally made by mixing clayey mud and hay. Though it has not much strength as concrete block etc., it is light, easily and cheaply produced, and heat insulation is excellent. It can be used in load bearing walls, and in brick filling of the timber frames. Mud mortar is used. Mud alone or mixed with lime is used as plaster material. It requires repairment after heavy rains. Earthquake resistant code of Turkey has provisions on adobe buildings. As this type has already been accepted for centuries, it can be said that this type will still be in use for many years.

EFFECT OF SOIL ON DAMAGE

Wallace, in his report on Varto (1966) earthquake, notes three types of geologic controls:

(a) Degree of saturation of the alluvium;

(b) Proximity to landslides;

(c) Relation to surface faulting;

The following is quoted from his report:

"Within the city of Varto geologic conditions appear to have controlled the damage to the complex of 26 buildings belonging to the Regional School and Agricultural Service. Varto is built on the alluvial plains of a river tributary to the Murat River and on benches rising 50 meters or more above the plains. An old river channel having two branches crosses the higher bench and passes directly under part of the school and agricultural service complex. The old channel is bordered by low subsidiary benches from 3 to 5 meters high. The water table was very near or at the surface in this old channel at the time this study was made, and many springs are present along its course. In the few exposures found, the channel appears to be underlain by poorly sorted alluvial material. In the bench on the northeast, alluvial fan deposits exist, of poorly sorted gravels containing clasts up to cobble size.

Of 14 relatively new buildings of reinforced concrete situated on the old river channel, 12 collapsed and one other was seriously damaged. In contrast, all 12 buildings of similar construction situated on the bench to the northeast remained standing - some were essentially undamaged and others were only slightly damaged. Many chimneys were not even thrown down. Inasmuch as most of the buildings on the old channel were two storeys high, a comparison should be made between the one storey buildings on the two sites. A small one-storey building, on the western side of the complex near the middle of the channel was damaged beyond repair and near collapse. On the other hand, some similar one-storey buildings on the highest part of the bench were almost unharmed. The conclusion seems to be that there was a decided difference in the shaking of the two sites, but whether the difference was in amplitude, spectrum or duration could not be determined."

It is a known fact that high underground water table increases the intensity, as shown by Medvedev in his formula.

Coming to Adapazari (1967) earthquake, a great part of the affected settlement was on the deposits of Sakarya river. The soil is alluvium, and the underground water table is about 1.00 meter (3 feet) from the surface. The collapse of five storied reinforced concrete buildings, may partly because of the predominant ground period, which is probably about the order of the natural period of the structures.

In the area, affected by Bartin (1968) earthquake, it can be observed that the single-storey local type buildings have experienced less damage towards the higher parts of the land, the thickness of the alluvium decreasing.

In Alaschir area (1969), almost all of the vineyard houses collapsed, being on the axis of the alluvial valley, while the town Alasehir had experienced comparably less damage, being on firmer ground.

In old Gediz town, microregioning studies were conducted by A. Tabban, from Earthquake Research Institute. The results confirm that damage is higher to flexible buildings such as reinforced concrete, and timber frame buildings in the lower part of the alluvium (thicker). The damage to the rigid masonry buildings on this type of soil, is not so severe.

After the new settlement was selected for Gediz, microregionalization technics were applied to guide town planners in assuring the optimum use of land.

EFFECT OF EARTHQUAKES ON REINFORCED CONCRETE STRUCTURES

No destruction nor major damage has been observed in well designed and built reinforced concrete buildings.

The major factors, decreasing the strength, can be listed as follows:

1. Unusually short and improper anchor bars for columns.
2. Improper composition of concrete (very coarse aggregate, inadequate amount of cement etc.).
3. Inadequate pouring and compaction of concrete (lack of vibration).
4. Inadequate curing of concrete (lack of wetting, after pouring, for hydration of cement).
5. Inadequate length of lapped splice in connections and corners.
6. Modification of dimension and location of members, from the original design.

Reinforced concrete buildings in general, proved to have enough ductility and strength, when they are properly designed and built, according to well known rules.

It is understood that the conformity to the rules, can only be assured by close inspection of construction activities in all of its three phases:

1. Design of building.
2. Employing material in conformity with the design assumptions.

3. Implementing the design, properly and employing workmanship in conformity with the design assumptions.

Lack of technical personnel in local organizations, is the main cause of inadequate inspection.

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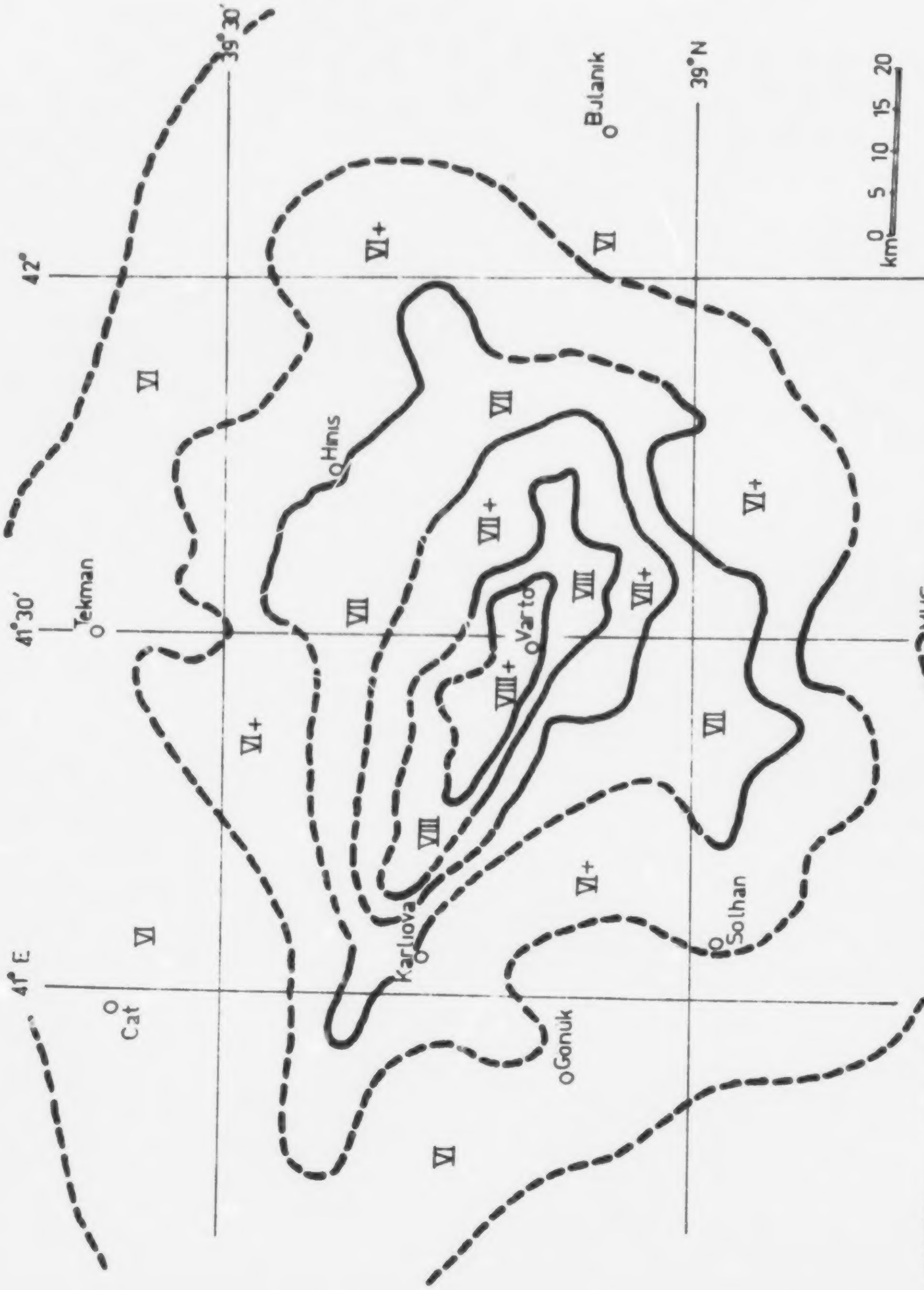
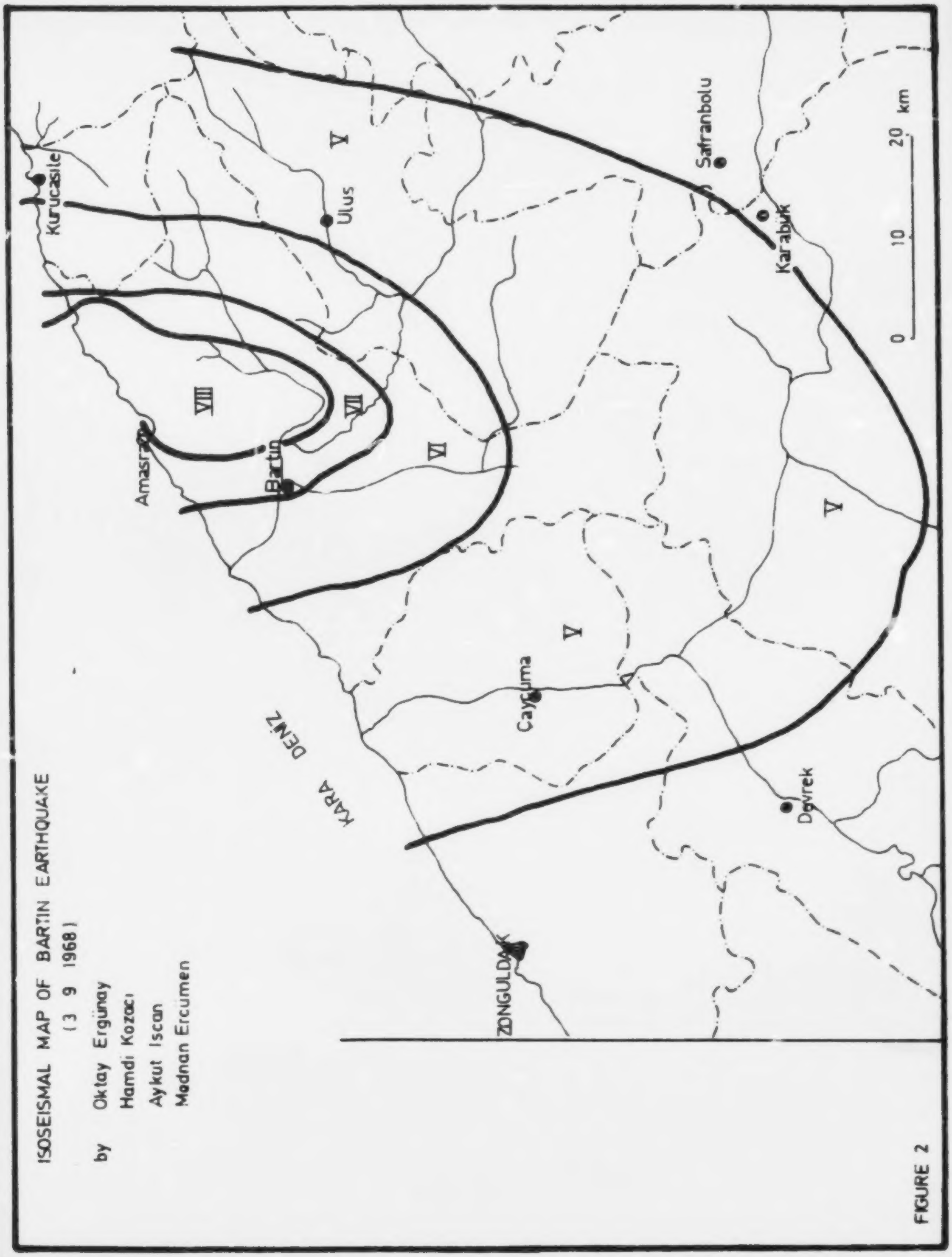

39°30'
42°
41°30'
41° E
39°N
Bulanik
Hinis
Tekman
Varto
Karliova
Cat
Gonuk
Solhan
MUS
VI
VI+
VII
VII+
VIII
VIII+
0 5 10 15 20
km

FIGURE 1

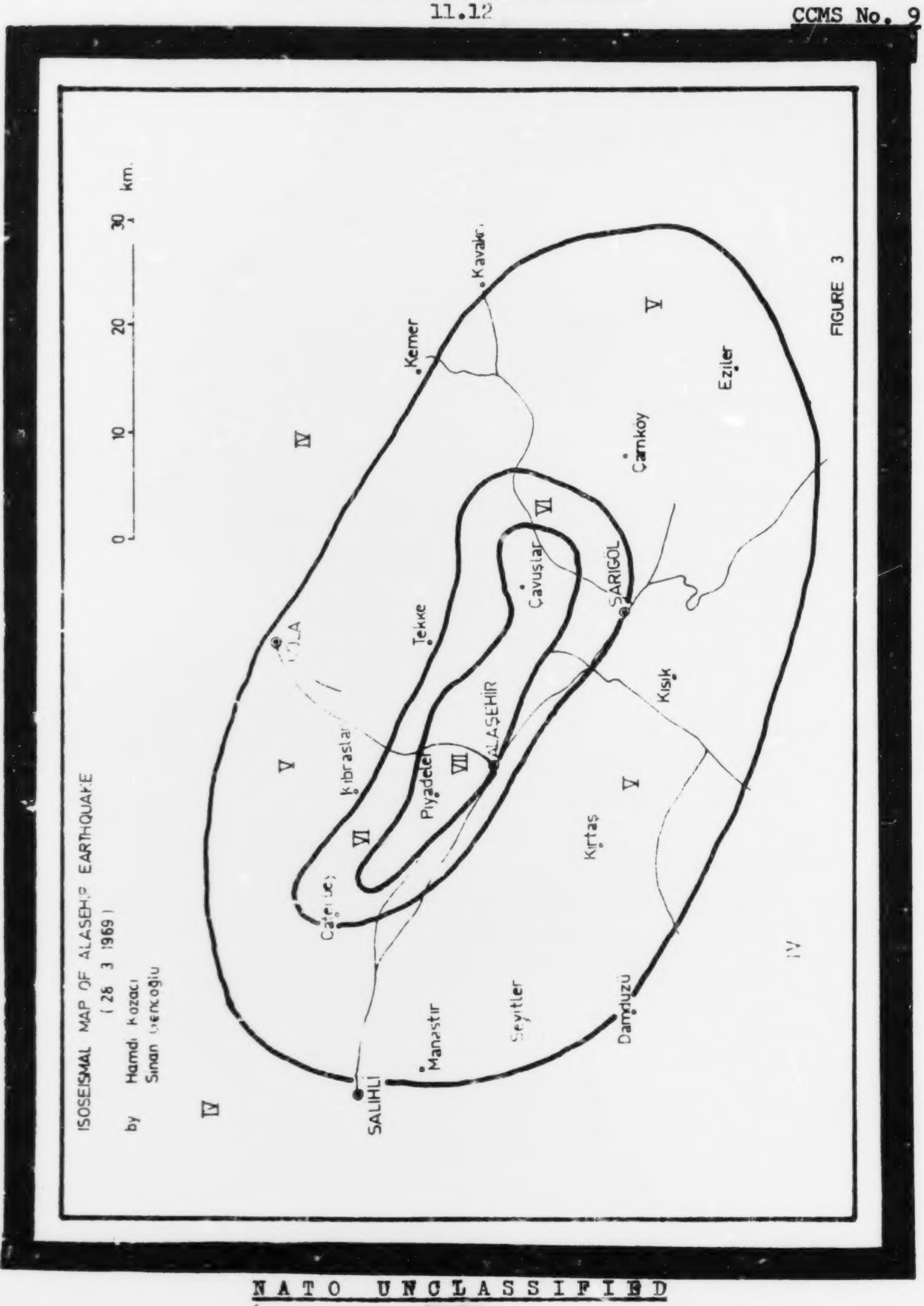
ISOSEISMAL MAP OF VARTO EARTHQUAKE
(19. 3. 1966)
h/ N.N Ambraseys and A.Zatopek


Kurucaşile
Ulus
Safranbolu
Karabük
Amasra
Bartın
Çaycuma
Devrek
ZONGULDAK
KARA DENİZ
V
VI
VII
VIII
0
10
20 km

ISOSEISMAL MAP OF BARTIN EARTHQUAKE
(3 9 1968)

by Oktay Ergünay
Hamdi Kozacı
Aykut Işcan
Madnan Ercumen

FIGURE 2


IV
V
VI
VII
VI
V
V
IV
IV
0
10
20
30 km.
SALIHLI
Manastır
Seyitler
Damdüzü
Caferbey
Kıbraslar
Piyadeler
ALAŞEHİR
Kırtaş
Kısık
SARIGÖL
Çavuşlar
Tekke
KULA
Çamköy
Eziler
Kemer
Kavaklı

ISOSEISMAL MAP OF ALASEHIR EARTHQUAKE
(28 3 1969)
by Hamdi Kozacı
Sinan Gencoğlu

FIGURE 3

The Rôle of Science in Protecting Man against Earthquake Disaster

Kazim Ergin

Technical University of Istanbul, Turkey

Seismologists all over the world have been studying earthquakes to get a better understanding of this natural phenomena, especially since the turn of this century. But the greatest advances were achieved during the last decade. All available modern methods and techniques are being employed in solving problems related to earthquakes which could in the end, help to protect man against it. By gathering large amount of data through systematic observation and by analysis, evaluation and interpretation of them we have come to a state of knowledge whereas we can plan, design and build structures that would resist and survive large and destructive earthquakes. An excellent case of history is provided by the recent San Fernando earthquake of the Los Angeles area. The damage done by this shock is far too small when we compare it with the amount of damage observed by some other recent earthquakes of similar magnitude that occurred elsewhere.

In many areas the intensity and acceleration of a strong earthquake are determined through visual inspection of the damage. For a sound engineering practice much better data are needed which can only be obtained by suitable strong motion instruments. In many countries including many in Europe, there are very few of those instruments in use. Establishing a well planned network of strong motion instruments might be considered one of the items of an international project to be taken up by CCMS. Whenever I speak about the question of earthquake resistant buildings, I always think of the problem of designing simple small houses that could withstand earthquake forces. These types of houses are needed in rural areas of most of the earthquake prone countries. Building materials could be selected or manufactured according to the supplies available in a given region. This conference could emphasize these problems and encourage research on the international scale.

As a result of the advanced level of our knowledge today, the seismologists have been seriously considering to predict earthquakes. There are already news of some successful prediction and research programs are in progress.

Earthquakes have occurred where no such events were known before. Such observations could be correlated sometimes with the injection of large amounts of water deep underground and in other cases with the detonation of atomic bombs or with filling with water of large dams. All these observations of man-made earthquakes lead seismologists to think that perhaps the energy stored within rocks could be released by controlled amount in areas of large destructive shocks and thus prevent the loss of life and property. This type of effort could eventually make the control of earthquake a possibility.

All these results of the scientific endeavour well known to seismologists particularly to Californian seismologists are excellent examples of how findings of pure and applied scientific research can be channelled into practical forms and thus science can be put in service for man's protection against natural disasters.

What I have tried to say up to this point summarizes very briefly what can and should be done to minimize the hazards of earthquake disaster. In many earthquake zones of the world the protection measures are far from adequate and when an area is striken by a severe shock, the whole scientific achievements are just phoney stories to the person involved. He wants immediate rescue shelter, food and a helping hand. I can not find words to express the importance of an alert emergency organization. During some recent earthquakes in many parts of the world we have observed that shortcoming of emergency measures have increased the death toll. It is our task to see to it that earthquake countries be better prepared to meet the challenge of disasters of that kind in the future. I hope that some practical and useful resolutions on this humanitarian aspect of earthquake may come out of this conference.

In Turkey we have had a destructive earthquake every two years or so since 1939. During this period tens of thousands of people lost their life. In this period of intense seismic activity geologists, seismologists, civil engineers and government officials have learned a great deal and become really interested. This interest was exhibited during the Gediz earthquake of March 1970 which was studied by so many geologists, seismologists and particularly engineers.

Before conclusion, I like to mention the effort of UNESCO to support the seismological development in many countries through which more efficient data were collected and acquired knowledge was disseminated to countries which need it.

CCMS No. 9

SAFETY AND SURVIVAL IN AN EARTHQUAKE

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THE SAN FERNANDO EARTHQUAKE OF 9TH FEBRUARY, 1971

by the National Academy of Sciences
National Academy of Engineering
Washington DC 1971

The Los Angeles region, which was hard hit on its Northern fringes by the moderate earthquake of 9th February, 1971 (Richter magnitude 6.6), is a region in which much attention has been given to the earthquake hazard. Even then, this natural violence of the earth directly affected more than 400,000 people in the city of San Fernando and surroundings by damaging or destroying homes and public facilities and utilities - with a cost of 64 lives and perhaps as much as a billion dollars. Collapse of a portion of the Van Norman Dam led to the evacuation of 80,000 inhabitants living below the dam for several days while water was drained from the reservoir to avert imminent rupture of the dam and a catastrophe unprecedented in this country.

The ground quaked early in the morning (about six a.m. local time) while highways were relatively free of traffic and before most workers had occupied offices in public buildings, and this minimized loss of life. Some of the earthquake losses can and will be restored in the near future; others, such as transportation disruption, severe damage to public utilities and facilities, and serious lowering of water-storage capacity, will take longer; and some losses can never be regained. These effects will force stricter earthquake preparedness measures in the Los Angeles area - and, we may hope, in other areas as well - as it is now clear that better preparation could have been made.

The particular location of this shock was not previously suspect any more than the heart of Los Angeles, where the damage would have been more catastrophic. Earthquakes of this size are not uncommon: more than 100 occur yearly around the world, but this one struck the edge of a great metropolis. It is certain that earthquakes of this size - and larger - will rock other places in the United States, rural and urban, in the future.

Earth scientists and earthquake engineers have been deeply concerned about their generally limited understanding of the hazards of earthquakes and by the consequent limited understanding by public officials responsible for the safety of millions. During the past few years, several reports have been written that both provide background knowledge and recommend action toward the mitigation of earthquake effects. The recommendations made in the reports listed in Appendix C are as valid today as when they were written. What seems needed now is to learn from the San Fernando Earthquake how best to prepare for and cope with the effects of future disasters of this kind.

1. SIGNIFICANCE OF PERMANENT GROUND DISPLACEMENT

Disruptions of the ground surface by faulting and other closely associated permanent deformations of rock and soil were much more important causes of structural failure during this earthquake than in any previous United States earthquake. This emphasizes once again the hazards associated with urbanization of active fault zones. On the other hand, many of the faults that broke during this earthquake were not generally shown on geologic maps published prior to the event, and none had been considered particularly active. The need for making structures safe is obvious. At the same time, more intensive geological, geophysical, and geodetic studies of earthquake-prone regions of the country must be made. Were there unrecognized geological clues that might have revealed that this area, and these faults, were particularly hazardous? Are there other geologically similar areas in which comparable earthquakes might occur? Merely asking such questions points up the necessity for interdisciplinary efforts by engineers, seismologists, and geologists in land-use planning for earthquake-prone regions.

2. MEASUREMENT OF STRONG GROUND SHAKING

An unprecendented description of the ground motions and the resulting building responses was provided by more than 200 stron-motion accelerographs. This National Oceanic and Atmospheric Administration network operated well during the earthquake. Among the records were several obtained on dams. One instrument, in the epicentral region, showed the highest acceleration ever measured during an earthquake; it indicated in detail the time sequence of the main shock and many of the major aftershocks. These measurements will form the basis for a re-evaluation of earthquake-resistant design. The accelerograph records obtained in about 30 large modern buildings will permit many significant studies of the design of earthquake-resistant structures. The success of this network, and the potential value of such data for the protection of the public, leads us to recommend strongly that the currently very inadequate strong-motion-accelerograph coverage should include numerous building structures and ground sites in all urban areas in seismic regions and important engineering structures such as dams and nuclear power plants.

In addition, greater effort and appropriate instrumentation should be devoted to studies of the effects of topography and the character of geologic material on the distribution and amplitude of strong ground motion.

3. SIGNIFICANCE OF THE STRIKING LOCAL GROUND MOTIONS

This earthquake demonstrated that local ground motion is not a simple function of the size of the shock. This magnitude 6.6 earthquake was associated (mainly in a restricted region some ten miles long and five miles wide along the Valley edge) with a severity of ground motion that was probably close to the maximum generated by any earthquake. An earthquake of greater magnitude would involve strong ground motion over a greater area consistent with longer fault breakage, and a greater duration of shaking.

The surface expression of the faulting and its character at depth as determined by seismological studies, showed that the crustal materials beneath the San Gabriel Mountains were uplifted and thrust toward the Northern margin of the Valley by six feet or more. In the Upper San Fernando Valley and in Sylmar, buildings were called upon to withstand exremely strong ground motions. In this local region, the motion consisted of both severe shaking and a heave upward and toward the South (perhaps in several episodes). The strong-motion accelerometer at Pacoima Dam, on solid rock, showed ground motions 50 to 75 percent of the earth's natural gravitational acceleration (with a few peaks equal to gravity) lasting approximately 12 seconds overall. The dam is less than two miles from the Sylmar Veterans Hospital, which sustained severe damage and loss of life.

4. BUILDING CODE REVISION

This earthquake has provided the first really comprehensive practical test of United States earthquake codes in and close to an epicentral region. Modern structures designed according to the earthquake requirements of the building code performed well in the regions of moderately strong ground shaking (peak accelerations of 10 to 20 percent g). In the region of very strong ground motion, however, some modern buildings were severely damaged. A few that collapsed would have caused many additional deaths had they been occupied at this early hour. If the duration of strong ground shaking had been appreciably longer than ten seconds, as it would be in a great earthquake, some of the severely damaged structures would almost certainly have collapsed. It is clear that existing building codes do not provide adequate damage-control features. Such codes should be revised.

5. BACK-UP EMERGENCY SERVICES

In earthquake-prone regions, service organizations such as the police and fire departments, and medical services will be put under heavy stress following an earthquake of significant size. The San Fernando Earthquake affected an area of only moderate size. It is necessary, therefore, to examine the organization and distribution of emergency services in the light of the fact that a major earthquake would affect a much larger area. Moreover, much of the loss of life and damage to property associated with an earthquake are attributable to after-effects such as fire, flood, or seismic sea waves.

The opportunity should be seized to make a careful evaluation of the performance of emergency services following the San Fernando Earthquake and to determine the kinds and extent of back-up required to prepare for a much larger event. Such a study, preferably involving federal, state, and other organizations, would provide guidelines for other earthquake-prone regions of high population density as well.

6. RAPID RECONNAISSANCE STUDIES

The vital need for rapid reconnaissance studies immediately following a damaging earthquake is once again emphasized by the experience of the San Fernando Earthquake. For example, the entire Northern part of the San Fernando Valley should have been systematically photographed from the air at very large scale (one inch equal to several hundred feet) on the morning of the earthquake in order, as quickly as possible, to locate sites of severe damage and to delimit the overall extent of such damage, as well as to identify visible surface expression of the faulting. But apparently no agency had the responsibility to initiate such an effort. It is clear, therefore, that an agency should be designated to assume the responsibility to initiate rapid reconnaissance studies of this type following future major earthquakes, and that adequate funding should be provided.

7. PROTECTION OF CRITICAL PUBLIC BUILDINGS

A striking consequence of the earthquake was the fact that four hospitals in the San Fernando area were damaged so severely that they were no longer operational just when they were most needed. Certain critical structures should be designed so that they will remain functional even after experiencing the most severe ground shaking. Included are hospitals, schools, and other high-occupancy buildings, as well as buildings housing police and fire departments and other agencies relied upon to cope with disasters. Basic utilities that must be depended upon to mitigate a disaster must also receive an extra measure of protection. Ordinary building codes cannot be depended upon to provide this extra protection, and special damage-control provisions should be mandatory to ensure such additional safety in high-risk areas.

8. EARTHQUAKE SAFETY OF DAMS

The near failure of the lower Van Norman Dam endangered the lives of tens of thousands of people. Such risks are clearly unacceptable. An improved program for bringing older dams in earthquake-prone areas up to the best modern safety standards is imperative, and these best standards should themselves be constantly reviewed. Many existing dams in all parts of the country have not been disigned to resist significant earthquake forces; these structures should be thoroughly examined and measures should be taken to reduce such hazards. Additional basic research into the behaviour of dams and soil structures during earthquakes will be required for the implementation of such a program. The fact that the Van Norman Dam did not quite fail totally should not be a source of comfort.

9. EARTHQUAKE HAZARD OF OLD STRUCTURES

During the San Fernando Earthquake, many old, weak buildings in the regions of strong and moderately strong shaking suffered severe damage, and the major loss of life occurred in one old building, the Sylmar Veterans Hospital, designed befor e the adoption of modern building codes. There are many thousands of such old buildings in California that will collapse if subjected to strong ground shaking. Programs should be undertaken to render such buildings safe, or to raze them, over a reasonable period of time.

A successful effort to improve or eliminate old structures has been underway for some time in the city of Long Beach, and in the city of Los Angeles especially hazardous parapet walls have been removed from several thousand buildings or have been strengthened. This earthquake dramatically demonstrated the value of such procedures. A much more extensive program to eliminate the major hazard of old buildings is strongly recommended. Urban renewal programs can provide a suitable opportunity for such improvements in California and in other earthquake-prone areas.

10. SAFETY OF BRIDGES AND FREEWAY OVERPASSES

A number of freeway overpass bridges collapsed during the San Fernando Earthquake, causing some deaths and resulting in significant local disruption of traffic. In an earthquake of greater extent, such interruption of transportation could greatly magnify the disastrous effects of the earthquake. Freeway bridges and important highway bridges should be disigned for adequate safety against collapse. Present standard code requirements for earthquake design of highway bridges in high-risk areas are grossly inadequate and should be revised.

11. SAFENESS OF SCHOOL BUILDINGS

It is noteworthy that school buildings in the region of strong shaking designed and constructed since enactment of the Field Act of the California State Legislature did not suffer structural damage that would have been dangerous to the occupants had the schools been in session. This demonstrated that one and two-story school buildings can indeed be made safe by practicable code requirements, permitting them to withstand very strong shaking combined with appreciable ground deformation beneath the structure.

Older school buildings, which did not meet the requirements of the Field Act, suffered potentially hazardous damage as a result of moderately strong ground shaking. The lesson is clear that such hazardous school buildings must be eliminated or strengthened. Appropriate authorities in all seismic regions of the country should take this lesson to heart.

12. STUDY OF DAMAGED URBAN DWELLINGS

This earthquake throws an almost unique light on seismic hazard in a modern urban environment. Extensive damage to small homes and small-business structures occurred in zones where severe shaking was accompanied by permanent ground displacement associated with the faulting. Therefore, much crucial information can be gained by an immediate dwelling-by-dwelling study of earthquake damage. Such a study should be conducted by appropriate federal, state, and local agencies, with a view toward developing sounder guidelines for building construction, particularly of one and two-story buildings.

13. EARTHQUAKE INSURANCE FOR HOUSES AND SMALL BUSINESSES

Because recognized geological evidence of active faulting was lacking in this particular area, the people who lost their homes and businesses in the Sylmar-San Fernando areas could have had no warning of the special hazards to which they were exposed. Permanent displacement of the ground caused by surface faulting, landslides, and consolidation and slumping of soils were responsible for much damage to structures. In many places, deformation of the ground beneath a structure greatly magnified the damaging effect of the ground shaking.

Such innocent victims of earthquakes should be protected by insurance, or the authorities must be prepared to consider better relief measures than those now used. The cost of repairing such unforeseeable damage should be shared by all who live in disaster-prone regions. A form of earthquake insurance that will be much more widely used should be developed, with Federal Government back-up if necessary.

14. PRESERVATION OF VITAL SUPPORT SYSTEMS

Damage to the Sylmar Converter Station, a key link in a system for transmission of elctric power into the Los Angeles area, will keep this system inoperable for about a year while replacement parts are manufactured. This demonstrates in a dramatic way the increasing vulnerability to earthquakes of our society's vital support systems. Networks for the distribution of electrical power, water, and gas, for disposal of sewage, and for transportation of food and other essentials continue to grow in size and complexity as the numbers of people dependent upon them reach into the multimillions.

The collapse of several highway overpasses during the earthquake had a limited effect on transportation, but such destruction could be more widespread in a larger earthquake, perhaps compounding transportation difficulties to disaster proportions.

A major unit of the water supply system, the Van Norman reservoir, was virtually eliminated without seriously disrupting distribution of water. Compounding of such effects in a larger earthquake is clear cause for concern.

For the crucial systems vital to millions of people, design of individual components is not adequate in the face of the known earthquake hazard. Continuing efforts must be exerted to build into the system sufficient redundancy to ensure against complete failure in the event of a major earthquake.

15. THE PROBLEM OF SEISMIC ZONING

The unexpected occurrence of an earthquake in this location and the concentration of the most severe damage in zones of ground breakage forcefully illustrate both the importance and the difficulty of responsible and practicable seismic zoning. No evidence from previously completed geological or seismological studies had been generally interpreted as indicating that the region affected was a more likely place for a damaging earthquake than many other parts of the Southern California seismic region.

This experience points out once again that the short-term local seismic history is not in itself an adequate base for estimating earthquake risk. Until we gain a better understanding of earthquake processes and probabilities, due regard for public safety demands that seismic hazard be considered high throughout wide areas, and seismic zoning maps must reflect this. Many agencies and groups are working constructively on the problem of recognizing seismic hazards, but this effort is so important that it deserves more support.

16. LAND USE AND GEOLOGIC HAZARDS

More than ever before, local communities are seeking guidance concerning environmental hazards of all types that should be taken into account in planning for the use of land to be developed. Permits for construction of residential and commercial buildings in areas subject to earthquakes, landslides, and flooding, for example, should only be issued on the basis of a meaningful evaluation of the potential risks and only after the purchaser is aware of all the known facts.

State and local government needs support in the form of well-conceived regulations in order to resist political and economic pressures to develop land in ways that are unwise in terms of environmental hazards.

17. STUDY OF THE SOUTHERN SECTOR OF THE SAN ANDREAS FAULT

The redistribution of crustal stresses caused by the San Fernando Earthquake cannot help but have some effect on the nearby segments of the San Andreas Fault, which has long been considered a source for much larger earthquakes. Because of this changed situation, the San Andreas Fault in this temporarily "locked" segment is a particularly critical area to study and to monitor, especially in view of its proximity to the largest metropolitan center in the Western United States. (The closest point on the San Andreas Fault to the center of Los Angeles in less than half again as far as was the epicenter of the San Fernando Earthquake). It is strongly recommended that additional research programs be started at once to study the Southern sector of the fault.

18. SEISMOLOGICAL STUDIES

The San Fernando Earthquake was the best monitored earthquake in United States history because of the high level of scientific preparedness in this area and the immediate response of earthquake researchers. Immediately available seismic data were inprtant in delineating the scope of the disaster, aided repair and reconstruction, and facilitated further scientific studies.

In the Los Angeles area, a telemetry-equipped seismic network that was in operation prior to the earthquake provided excellent records of pre and post-earthquake seismicity, but even this network could have been markedly improved in effectiveness by a greater number of telemetry-equipped stations and a more comprehensive seismic monitoring program. It is clear that, prior to the earthquake, seismological information even for this region was not as complete as it could have been, and indeed should have been, given the capabilities of present technology. Pre and post-earthquake geodetic observations should be an intrinsic part of such monitoring systems. Both seismologic and geodetic capabilities are urgently in need of upgrading in all earthquake-prone regions of the country.

The seismic data gathered during and following the earthquake provided the basis for locating the sources and determining the mechanics of the faulting at depth. Such studies, together with geologic and geodetic studies, will also yield important information about the earth deformation that occurred in association with this earthquake and its aftershocks. This will be important in assessing the seismic hazard elsewhere. The San Fernando Earthquake is a reminder that a vastly improved understanding of earth movements at all scales is needed.

TOWARD REDUCTION OF LOSSES FROM EARTHQUAKES

Conclusions from the Great Alaska Earthquake of 1964

Prepared by : The Committee on the Alaska Earthquake
Division of Earth Sciences
National Research Council

RECOMMENDATIONS ON EARTHQUAKE LOSS-REDUCTION

1. Studies should be undertaken to develop improved earthquake-resistant designs, and more accurate and reliable methods of structural analysis, for all types of structures and for a variety of ground conditions.
2. Improved regulatory systems for control of structural and nonstructural design and of construction in seismic areas are needed.
3. Periodic reappraisals should be made of major dams, reservoirs, storage tanks, and older buildings in seismic areas to identify existing hazardous structures and to reduce hazards to life and limb.
4. Increased effort should be devoted to collecting data on ground movements and associated physical-field changes both between and during major earthquakes.
5. Needed improvements in the tsunami-warning system include better recording, faster transmission, improved analysis of data, more knowledge of the generation and propagation of tsunamis, and greater understanding of the human response to such warnings.
6. Studies are needed to make earthquake forecasting and hazard evaluation practicable; not only the feasibility but also the socioeconomic implications of such forecasting need to be studied.
7. Earthquake-hazard maps should be made of all densely populated seismic areas.
8. Informing the threatened public of the nature of earthquake hazard and education on means of reducing risk are vital to effective measures of loss reduction and loss adjustment.
9. A comprehensive study should be undertaken concerning the problems involved in establishing a system of earthquake insurance that will be widely used and that will lead not only to loss adjustment but also to loss reduction.

10. Emergency funds and personnel should be available to collect and analyze data from major earthquakes wherever they may occur.

11. The mechanisms for funding earthquake research and data collection should be improved.

12. A federal task force should be established to recommend a comprehensive government program directed toward reduction of losses from hazards such as earthquakes; at the same time, individual states or regional authorities should give attention to appropriate mechanisms for coping with these hazards.

* * *

The report of the Committee on the Alaska Earthquake is planned as an eight-volume series with the following title:

THE GREAT ALASKA EARTHQUAKE OF 1964

- GEOLOGY
- SEISMOLOGY AND GEODESY
- HYDROLOGY
- BIOLOGY
- OCEANOGRAPHY AND COASTAL ENGINEERING
- ENGINEERING
- HUMAN ECOLOGY
- SUMMARY AND RECOMMENDATIONS

By February 1969, only the volume on Hydrology (NAS 1603) had been published, and it is available from the Printing and Publishing Office, National Academy of Sciences, 2101 Constitution Avenue, Washington, D.C. 20418. Publication of the remaining volumes is expected during the next three years.

EARTHQUAKE HAZARD REDUCTION

Executive Office of the President
Office of Science and Technology
August 1970

INTRODUCTION

In a series of thoughtful reports issued during the pas decade, various responsible scientific, professional and governmental groups in the United States have pointed to the catastrophic potential of a great earthquake with respect to human suffering and property damage. These reports have strongly urged the Federal government to undertake or to sponsor a large number of programs and studies in such fields as seismology, geology, engineering, government and disaster relief (including insurance) that are logically related in the context of earthquake hazard. The specific proposals have ranged from immediate steps, which would promptly reduce some aspects of the hazard, to research on the basic causes of earthquakes, which could lead eventually to more effective means of earthquake hazard reduction.

Partially in response to these studies, the Office of Science and Technology has established a Task Force on Earthquake Hazard Reduction. The mission of this Task Force is to develop an appropriate national action program for the reduction of the human suffering and property damage attendant upon an earthquake, including the earthquake-associated geologic hazards and non-geologic (direct) hazards.

Numerous specific recommendations, particularly in the fields of seismology, geology, and engineering, already have been carefully developed and explained. Possibly the most significant of these are included in the following publications:

"Earthquake Prediction: A Proposal for a Ten Year Program of Research", Ad Hoc Panel on Earthquake Prediction, prepared for the Office of Science and Technology, (May 1965);

"Proposal for a Ten Year National Earthquake Hazards Program: A Partnership of Science and the Community", Ad Hoc Interagency Working Group for Earthquake Research, Federal Council for Science and Technology, (December 1968);

"Toward Reduction of Losses from Earthquakes: Conclusions from the Great Alaska Earthquake of 1964", National Academy of Sciences, (1969);

"Earthquake Engineering Research", National Academy of Engineering, (1969);

"Seismology: Responsibilities and Requirements of a Growing Science", National Academy of Sciences:

Part I - "Summary and Recommendations", (1969)
Part II - "Problems and Prospects", (1969)

The Task Force has carefully considered all of the specific proposals listed in the aforementioned studies and reports in the process of defining the best national program leading to the reduction of earthquake hazards. Further, the Task Force has considered additional recommendations, particularly in socio-economic fields which have received less attention than the physical sciences. The overall program will require the best coordinated inputs from the public and private sectors.

It should be made clear that the majority of the recommendations brought to the Task Force's attention have not been included in this report. A number of costly proposals have been omitted, or included on a substantially reduced basis, since they had little or no relevance to a national program on earthquake hazard reduction.

PROGRAM BENEFITS

In a basic sense, no program of earthquake hazard reduction will have significant direct benefits to the public until an earthquake occurs. An earthquake cannot at present be predicted with respect to time, location, and size; therefore, any benefit to be derived from a hazards reduction program must relate to a postulated earthquake. Great destructive earthquakes in the United States have not been frequent events, yet several have occurred during the relatively short span of historic time. It must be assumed that others will uccur during the years ahead.

Benefits may be viewed and identified from various standpoints. Thus, we can focus upon increased safety to the public, more and better disaster relief, and reduction of monetary loss or provision for recovery of loss. A different kind of benefit can be the increased knowledge that will be immediately used to reduce the hazard; for example, a building code provision can go into effect at once. Another can be fundamental research or study that is absolutely essential as a basis for other research that will create direct benefits. Or, finally, the benefits can be in the planning or the information needed for planning, for future improvements in safety such as wiser distribution of urban structures and upgraded building codes.

An entirely different aspect is the degree or extent of benefit. Presumably a parapet ordinance, for example, could have an immediate and general effect on safety (i.e. by eliminating hazardous parapets and other building appendages). However, a new provision in a building code affects only the new buildings and so affects the relatively few people who use them. Urban planning, new school safety laws, new regulations for FHA, post offices, etc., are in the same category.

Information on costs is essential for decisions on the most effective use of limited funds, and the soundness of such decisions necessarily depends upon appraisals of cost-benefit relationships. The need for realistic cost-benefit studies in the context of earthquake risk is discussed farther on in Recommendation No. A-7, but a more immediate comment on application of the term "benefit" is offered here.

Any hazard-reduction program begins to produce benefits as soon as it is activated. These benefits are intangible but real, as they take the form of reduced risk to life and property. They accrue without regard to the actual occurrence of damaging events, even though they are not translated into tangible form until such an event does take place. Thus a major earthquake may clearly reveal certain benefits deriving from a viable hazard-reduction program, but in effect this is no more than a demonstration of benefits that have existed throughout the program as contributions to safety for people and property. Protection against a known hazard is as real for the beneficiary before a damaging event as afterward.

Hundreds of possible recommendations have been considered in an effort to formulate a complete, yet workable, program for earthquake hazard reduction. A considerably refined list of interrelated recommendations, all of high priority, has evolved in the form of Table 1. The three-fold grouping into time-related categories reflects appraisals of when significant public benefits would begin to derive from action on each of the recommendations. The time-benefit categories are:

A. Potential for significant benefits beginning in the near term (in less than 5 years)

B. Potential for significant benefits beginning in the intermediate term (within 5 to 10 years)

C. Potential for significant benefits beginning in the long term (after 10 years)

The foregoing categorization perforce involves no more than best estimates. Thus it is quite possible, and indeed it is likely, that one or more unexpected breakthroughs in knowledge will change some expected benefits from long term to short term.

In general, there is a correlation between the extent and importance of benefits from research and the difficulty and cost of the research effort. In time, the greatest benefits are likely to come from the longer range studies. These benefits will come not only from the application of new knowledge, but also from the changes in public attitude resulting from a better understanding of earthquakes and their effects. Many people outside the engineering and scientific communities do not appreciate the seriousness of the gaps that currently exist in our fundamental knowledge of earthquakes and their effects, but most of these gaps are capable of being filled in the course of a well-balanced program that emphasizes long term as well as intermediate and short term benefits. Hence, it would be a serious mistake to allocate most of the available financial resources to thos recommendations having potential short term benefits to the neglect of the others. Neither the three categories nor the order of listing of the recommendations presented below are intended to indicate an order of priority.

The high priority recommendations of the Task Force are given in capsule from in Table 1. These have been summarized from the detailed recommendations on the pages that follow.

Table 1: HIGH PRIORITY RECOMMENDATIONS

Short Title List

A. Significant benefits probably beginning to accrue in the short term (less than 5 years after beginning of recommended action):

A-1 Engineered earthquake resistance for new governmental facilities
A-2 Engineered earthquake resistance for new non-governmental facilities
A-3 Seismicity (or risk, or probability) maps
A-4 Earthquake geologic hazards maps
A-5 Urban planning to minimize seismic hazard
A-6 Earthquake hazards abatement in older facilities
A-7 Cost-benefit studies
A-8 State and local government role in geologic hazards reduction
A-9 Federal total plan for immediate response
A-10 Federal responsibility in reconstruction
A-11 Federal responsibility in earthquake insurance
A-12 Strong motion equipment and analyses
A-13 Full scale testing

B. Significant benefits probably beginning to accure in the intermediate term (5 to 10 years after beginning of recommended action):

B-1 Applied research on seismic design criteria
B-2 Post-earthquake analyses
B-3 Fault mapping, dating, and specialized geologic mapping
B-4 Local seismic networks
B-5 State responsibility in earthquake hazards reduction
B-6 Newly discovered hazards and older construction
B-7 Taxes and tax reform

C. Significant benefits probably beginning to accrue mainly in the longer term (10 years or more after beginning of recommended action):

C-1 Basic research in earthquake engineering
C-2 Earthquake prediction research
C-3 Earthquake control research
C-4 Geodetic research
C-5 Worldwide seismic network continuation
C-6 Tsunami hazard research
C-7 Basic research in seismology
C-8 Basic research on causes and mechanisms of crustal failure

While the report directs its attention only to the earthquake hazard which is of varying importance throughout the United States, many of the programs are of equal importance to other natural hazards. It is notable that those areas of the United States that are least concerned about earthquake hazard are most concerned about hurricanes, for example. And the principal structural concepts that make a building able to resist earthquakes successfully are either identical or similar to those that provide adequate wind resistance (A-1, A-2, B-1). The planning concepts (A-5), the disaster relief programs (A-9, A-10), the insurance (A-11) and tax recommendations (B-7), the hazard abatement proposals (A-6, B-6) and the intergovernmental cooperation areas (A-8, B-5) have equal validity for all natural disasters. The geological and mapping studies and recommendations (A-4, B-3) contained in the report are necessary for protection against landslides and other geological hazards. As a result, the major recommendations of the report are suitable for use throughout the United States and should not be confined to those areas that traditionally are concerned about earthquakes.

CCMS No. 9

URBAN RECONSTRUCTION PLANNING: THE ALASKA EXPERIENCE

Lidia Selkregg
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Federal Field Committee for
Development Planning in Alaska

19th May, 1971

Reconstruction of Alaska's communities after the 27th March, 1964, earthquake is a story of success but also a story of failure for planners. I say this as a geologist and planner who actively participated in the preparation of redevelopment plans for all the communities affected by the earthquake.

Although it had been known by geologists and engineers employed by federal and state agencies that most of the populated area of Alaska lies in an area of high seismic activity, this fact had not been recognized by planners or local, state, and federal officials in planning for development of land uses and capital improvements in urban centers.

The effect of the earthquake was drastic and varied.

In Anchorage, the most sophisticated community in the state, three large landslides were triggered in the most built-up area of the city - the business district and two of the most valuable residential areas.

In Seward and Valdez, large submarine landslides coupled with land subsidence destroyed the cities' industrial waterfronts. In Valdez, in addition, instability of soils throughout the community made the whole community uninhabitable.

In Kodiak, land subsidence, coupled with the effects of innundation resulting from a tsunami, destroyed the industrial and commercial sectors of the community.

In Seldovia, land subsidence left the community's industrial waterfront, commercial facilities and many residences under water at high tide.

In Cordova, land uplift left the small boat harbor, city dock, and other waterfront activities high and dry!

Programs for relief and recovery were needed urgently, but Alaska's planning resources for a reconstruction task of this magnitude were limited. There were only 16 practicing firms of architects and engineers and 8 planners in the state, and the planners were all employed by public agencies. There was no state planning agency adequately staffed to make the multitude of necessary surveys and studies, or prepare the plans needed to guide reconstruction. Planning commissions were active in only two of the affected communities. Long-range comprehensive land-use plans were available for Kodiak, Anchorage, Cordova, and Seward, but in their preparation, the communities' vulnerable seismic conditions had been ignored; they included no guidelines for reconstruction, relocation, or innovative planning concepts.

The principal tasks that faced those in charge of disaster relief and reconstruction were to provide for rapid temporary restoration followed by permanent reconstruction. The temporary restoration phase was handled effectively by private citizens and local governments with the assistance of the military and other federal agencies. In a matter of days, all citizens were housed and temporary utilities established in all communities.

The permanent reconstruction phase required more time than was allowed! It was recognized that such a major disaster required rapid action for recovery. It was also recognized that disaster presents a rare opportunity for revitalizing the urban structure, developing new land-use patterns directed at safeguarding lives and property, and strengthening the economic base through improved land-use. Teams of soil scientists and engineers were promptly organized to evaluate the extent of high risk areas or other limiting factors to be considered by planners in developing criteria for reconstruction. Consultant firms with national reputations were hired to assist local planners in the development of plans providing for future safety and to rebuild safe and economically sound communities. These plans were accomplished. However, the goals of the plans were not always realized. There was a lack of time to substantiate some of the concepts used by the consultants, a lack of continuity in planning staffs (the consultants originally hired were not retained to carry the program through from the planning phase to the implementation phase), and a lack of time for educating the communities on the value of long-range planning. These factors, together with the speculative build-for-today-and-let-tomorrow-fend-for-itself approach used by many local officials and private citizens, and the quickly forgotten impact that the earthquake had had on peoples' lives, led to plan changes, compromises, and unnecessary delays in final reconstruction activities.

Time limits my making a full review of the various redevelopment plans and the considerations that went into their preparation. I will, however, present a few examples of the changes made to the original plan recommendations which may have a long-range impact on the communities.

In Kodiak, the first plan suggested moving the commercial core away from the waterfront to higher ground and attempted to combine multiple dwellings with a non-industrial retail complex. It also recommended that the land adjacent to the harbor, after being filled, be used for storage and industrial staging areas, badly needed by the growing fishing industry. The plan was changed to allow for the reconstruction of an industrial-commercial complex on the waterfront - as before the earthquake - an unwise decision from both the standpoints of safety and long-range land-use economics. A requirement that all structures built adjacent to the waterfront be constructed of reinforced concrete or reinforced masonry to withstand the force of future tsunamis was also deleted at the request of the Kodiak City Council. On the other hand, Kodiak is today a new community with new stores fronting on paved streets, with adequate packing facilities, and boasts a revitalized fishing industry based on a new boat harbor - protected by a seawall and breakwater, and new canneries using improved methods of fish processing and shipping.

In Seldovia, the consultants had prepared a plan that had kept the community's quaint character - a requirement for a community whose future depends on an increased tourist economy in addition to its fishing industry. Plans were modified, however, to respond primarily to the waterfront needs of canneries, boat yards, and storekeepers. To make room for extensive land fill, historical landmarks were destroyed; the project moved slowly due to controversy and misunderstanding; and today, besides losing its quaint waterfront, Seldovia has lost most of its canneries' activities.

Anchorage was the only community at the time of the earthquake that had in force regulations and ordinances needed to control proper development. Moreover, it had just completed a central business district plan, prompted by the need to create a strong commercial-financial core. Immediately after the quake, soil studies were made to determine the extent of the high risk areas and based on these findings, a land-use plan was prepared. The plan proposed the movement of the primary business core away from the unstable bluff to the adjacent land where more favorable soil conditions exist. The plan designated the risk areas to be used for parks, parking, and other open-space activities. In these open spaces, the only construction to be allowed was construction of pavillions, oriented towards tourist trade. Detailed suggestions for pedestrian malls to revitalize the city core were also made an integral part of the plan. Although some people saw in this plan a method of improving the central business district and putting into effect many of the proposals presented in the pre-earthquake study, as well as protecting the city from future major loss as a result of earthquakes, no public support for the plans developed. With large portions of the central business district already destroyed, many businessmen disapproved of further demolition as being too destructive of the city's economy. (It must be added that the project's method of land acquisition based on post-earthquake prices was completely unrealistic to allow for effective reassembly of land.)

The decision was made immediately to limit the extent of replanning to one slide area - the Downtown Slide. An earth buttress was designed and built to stabilize the soil that had failed and to prevent the adjacent land from sliding in the event of another earthquake. Nothing else was done to improve the city's core area. In the last five years, intensive construction has occurred in areas considered of high risk by soil scientists. One of the slide areas - the L Street Slide - was never considered; it was, of course, not stabilized.

But plans for reconstruction were not invariably abandoned. Let me use Valdez as an example.

The loss of life and the damage at Valdez was so great that a decision was made to move the entire community. Federal officials expressed skepticism regarding the relocation of a community with a population of only 500 people, but the position of Valdez as an ice-free port and terminous of the Richardson Highway, the shortest and most direct route from tidewater to Fairbanks, and the potential of Valdez as an outlet for development of the natural resources of the interior weighed heavily in the decision to relocate the community. After extensive soil studies, Mineral Creek - the city's first location at the time of the goldrush - was approved as the new townsite. The tremendous efforts of planning and co-ordination that took place in acquisition of all private property at Valdez and relocation of 135 families, 26 individuals, 44 businesses, and construction of new roads, schools, hospital, public facilities, city dock, and small boat harbor cannot be quickly summarized.

The move was rapid and reconstruction closely followed a land-use plan which had incorporated concepts directed to population growth, weather conditions, convenience of shopping, amenities related to development of residential areas close to schools and recreation facilities, expanded waterfront activities, and enhancement of the tourist potential of the area. By fall, 1966, all public facilities had been constructed. This acted as a catalyst to the relocation of residences and businesses. Total relocation was completed by fall, 1967 - a little over three years after the earthquake. The only feature sacrificed in the rapid redevelopment was the aesthetic aspect of construction, a consequence of the lack of adequate financing of private development.

Cordova is the most successful project. Through the reconstruction, recommendations made in a comprehensive land-use plan prepared in 1962 were implemented by improving access to the waterfront and providing additional land for industrial use.

In evaluating the planning process that took place during the recovery period, it is evident that three planning phases are needed to successfully approach planning for areas subject to earthquake disasters - prevention, immediate relief, and long-term recovery.

It was the lack of these established planning systems that created problems, some with long lasting effects, in the reconstruction of communities following the 1964 Alaska earthquake.

What recommendations can be made to this effect as a result of the Alaska experience? What tools are needed to make reconstruction more responsive to the need to improve and prevent occurrence of disasters? It is my opinion that a state disaster prevention planning program should be initiated by the state with the assistance of the federal government and should include, among other things:

preparation of an overall state plan which evaluates potential disaster areas and their treatment in the event of a disaster;

initiation of programs to prevent or minimize disasters such as soil stabilization, harbor protection, avalanche control, and others;

adaptation and enforcement of statewide building codes;

co-ordination of local, state, and federal activities related to development planning in potential disaster areas;

study and evaluation of all state and federal programs applicable to disaster recovery - and - planning for immediate assignment of one agency as a co-ordinator of all physical planning activities;

financial and technical assistance to local planning agencies in preparation of comprehensive plans including hazard considerations as part of land-use determinations;

financial and technical assistance to local governments for the enforcement of zoning ordinances, subdivision regulations, fire codes, building codes, and other regulations required for safe and proper development

initiation of programs of public education.

State and federal governments should cooperate in the preparation of regional plans including data on geology, climatology, ecology, and social-economic conditions, so that it will be available for reconstruction planning.

Assistance should be given to local governments for the acquisition of lands which are considered to be subject to earthquake induced damages such as slides, subsidence, innundation, and others, for the development of these lands as part of open-space activities - badly needed in most communities.

Clear distinction should be made between disaster relief and long-range recovery; to this endeavor a disaster relief plan should be available for immediate implementation to prevent the hardship caused by the problems of temporary relocation of families and businesses which caused, in the case of Alaska earthquake reconstruction, many of the delays and difficulties in plan implementations.

It is also important that a task force entrusted with the responsibility of preparing the redevelopment plans be established immediately following the disaster, and, besides planners, it must comprise geologists, engineers, economists, sociologists, architects, appraisers, and attorneys. This task force should be familiar with the state and should become the recipient of all input from consultants and other interested technicians who visit the state as a result of the disaster. To do so, an active list of scientific and technical personnel within the state should be prepared and kept jointly by state and federal governments.

Most of all, planners and local government officials must be educated to recognize environmental constraints as an important factor to be considered in the determination of land uses.

The irresponsible way by which local governments in Alaska, at present, are treating known earthquake hazard areas, concerns me greatly. I wish that as careful consideration could be given by Alaska environmentalists to the construction occurring on high-risk areas in urban centers, as is given to the possible effects of earthquakes on the proposed pipeline from Prudhoe to Valdez. After all, the human species in the cities is as valuable as the tundra, the caribou, and the lichens in the wilderness.

CCMS No. 9

THE NATIONAL EMERGENCY COMMITTEE
31ST MAY, 1970 EARTHQUAKE
PERU

A full report on the earthquake which took place on 31st May, 1970 at Chimbote y Trujillo, Peru, was presented at the meeting.

Copies of the original text in Spanish may be obtained from:

Auxilio Social de Emergencia Regional (ASER)
Ministerio de Salud,
LIMA,
Peru.

Un rapport détaillé sur le séisme du 31 Mai, 1970 à Chimbote y Trujillo, Pérou, a été presenté au cours de la réunion.

Le texte en espagnol peut être obtenu à l'adresse ci-dissus.

SEISMIC RISK STUDIES IN THE UNITED STATES

S.T. Algermissen

SYNOPSIS

A new Seismic Risk Map of the United States is presented, together with strain release and maximum Modified Mercalli intensity maps of the country. Frequency of occurrence of damaging earthquakes was not considered in assigning ratings to the various zones on the risk map, but studies of earthquake frequency are included as an aid in using the risk map. The Seismic Risk Map is suggested as a revision of the Seismic Probability Map prepared by the Coast and Geodetic Survey in 1947 and withdrawn in 1952.

Copies of the text may be obtained from the following address:

Chief, Geophysics Research Group,
Coast and Geodetic Survey,
ESSA,
US Department of Commerce,
Rockville, Maryland,
U.S.A.

CCMS No. 9

SOME DEVELOPMENTS IN STATE AND FEDERAL EARTHQUAKE HAZARD REDUCTION PROGRAMS

By

Karl V. Steinbrugge
Professor of Structural Design
University of California, Berkeley

Major Problem Areas

The long-standing American tradition of local control over building construction has been expressed through local building codes, and these codes now include provisions for earthquake bracing of new construction located in many earthquake hazard regions. The technical provisions and the philosophies involved are adequately covered by other papers presented at this conference, and need not be repeated here. This paper, then, will give emphasis to the major unresolved earthquake hazard problems, and the growing non-local governmental concern over these and related problems.

It is of value at this international conference to very briefly review the history and present status of the earthquake provisions of local building codes in order to obtain a better perspective of the reasons and objectives for the growth of interest in programs at State and Federal levels.

The great earthquake disaster which struck San Francisco, California in 1906 had many lasting impacts, but surprisingly it had not more than short-lived influence on building codes. Substantial renewed interest was shown in the problems relating to earthquake hazards after the Santa Barbara, California earthquake of 1925, but this interest also had minimal impact on effective hazard reduction programs. The Long Beach, California earthquake of 1933, which lead to 102 lives lost and which destroyed many buildings in a number of cities including Long Beach, resulted in strong local building ordinances throughout the metropolitan Los Angeles area. In addition, a California state law was passed at that time which required that all new public schools be designed and constructed to be highly earthquake resistive. This State of California law, commonly known as the Field Act, has over the years proven to be very successful.

As strange as it might seem, it wasn't until about 1950 that most of the cities within the metropolitan San Francisco area were willing to acknowledge the peril of earthquakes by including provisions in their local building ordinances. Since 1950, earthquake bracing requirements within building codes have become commonplace for most communities in the western part of the United States.

Major Unresolved Public Policy Areas

From the foregoing brief history, it is clear that most building construction still in existence in California and in other states was built prior to the enactment of earthquake bracing laws. Many of these older buildings are hazardous in the event of a great earthquake. The major life loss in a great earthquake undoubtedly will result from the collapse of non-earthquake resistive construction which includes dams as well as buildings.

The City of Los Angeles has had a program to reduce the most serious of the hazards relating to these older buildings, namely the removal or bracing of hazardous parapets and appendages. Other California cities are giving thought to taking some sort of action, but basically the overall problem of hazardous older structures remains unsolved by local government.

Thus, the first and possibly foremost problem requiring public policy attention is:

Viable programs must be developed to substantially reduce the earthquake hazard of older non-earthquake resistive, collapse hazard structures of all types, including dams.

Present building codes, particularly in the United States, have given little or no direct attention to the problems of earthquake geological hazards. For an extreme case, virtually no local building code specifically restricts the construction of a major structure, such as a hospital, on the trace of a major known active fault. The reasons for this are manyfold, with not the least of these being the lack of adequate criteria for use by local building officials to develop and implement adequate code provisions.

Thus, the second major problem requiring public policy attention is:

Integrated geologic, land use, and engineering criteria must be developed on a practical basis, and these criteria must be implemented through viable programs.

Extensive research, both pure and applied, is being conducted on buildings and on other structures, on construction materials, on soils, in geology, and on many other subjects. The existing directions of public policy is favorable towards research and other studies leading to earthquake hazard reduction. The vast majority of the support for this public policy is at Federal and State levels, and not at local levels. The need in this subject area is not for a new public policy, but is:

Substantially increased support is necessary for integrated research programs, both pure and applied, leading to earthquake hazard reduction.

State and Regional Interest

The foregoing discussion of major public policy problems shows that several subject areas must receive additional attention. For various adequate reasons, local government has been unable to adequately solve these problems. Not the least of these reasons is the financial implications of implementing adequate policies. Quite understandably, then, State and Federal government has turned its attention to these topics.

The State of California has shown more interest in solving earthquake related problems than have other states and thus this discussion will briefly turn its attention to California.

The first unified attack on these problems in recent years was the Geologic Hazards Advisory Committees for Program and Organization which was established by the Resources Agency of California. The report of these committees, issued in April of 1967, was entitled "Earthquake and Geologic Hazards in California".

A second impetus given to the establishment of State programs was the publication "Earthquake Hazard in the San Francisco Bay Area; A Continuing Problem in Public Policy" which was published by the Institute of Governmental Studies at the University of California. The solutions indicated for the San Francisco Bay Area demanded something greater from a governmental attention standpoint than that being provided by the many local jurisdictions, and a regional governmental approach seemed one possible alternate to State involvement.

With the foregoing background, it may be readily understood why the California Legislature over a year ago established its Joint Committee on Seismic Safety. This committee has been a major undertaking involving over 70 persons who donate their time towards giving advice and guidance to this legislative committee. These advisers are all experts in their own fields which include many disciplines: architecture, structural engineering, geology, soils engineering, city planning, insurance, banking, among others.

The San Fernando, California earthquake of 1971 placed special emphasis on the need for quick action to remedy some of the most serious earthquake hazards which became obvious from this earthquake. A number of bills were introduced into the State Legislature, with some topics being as follows:

1. Hospitals

The excessive damage which occurred to the newly completed earthquake resistive Olive View Hospital came as a shock to structural engineers and architects as well as to the public. Three other hospitals also were severely damaged; of these, two were earthquake resistive. Hospitals are a special class of structures which, after a disaster such as an earthquake, are in greater need after the event than before the event. At present, efforts are being made to place hospitals under a type of state control similar to that of the Field Act which regulates public school construction.

2. Strong Motion Seismic Instrumentation

Legislation is being considered which will help to satisfy the serious need for much greater information regarding the strength and other engineering characteristics of earthquakes. The opportunities to record a major earthquake in the epicentral region are rare, and no opportunity must be lost. Thus, the Joint Seismic Safety Committee is considering legislation which will, in effect, greatly increase the network of strong motion instruments throughout the State of California.

3. Dwelling Construction in Fault Zones

Construction in earthquake active fault zones requires far greater attention than has been given to it by building codes. To the author's knowledge, there are no effective building ordinances at any level of government which adequately control structures in and about a fault zone. Therefore, legislation is under study which is intended to reduce this particular hazard.

Other legislation is being proposed and some of it is of equal importance. All of this legislation is showing a growing awareness of earthquake hazards and the need for a more centralized governmental approach to adequately solve these problems. It is anticipated that State government involvement will continue to grow where local governments appear to be inadequate.

Federal Interest

The United States Federal government has increasingly supported earthquake engineering research, but many feel that the increase must be accelerated. This research has been principally through the National Science Foundation and the United States Coast and Geodetic Survey (now the National Oceanic and Atmospheric Administration). In addition, in recent years the United States Geological Survey has become interested in some earthquake engineering problems along with its considerable interest in earthquake geologic hazards.

However, there has been no overall unified Federal approach to pure and applied programs relating to earthquake hazard reduction. This deficiency, among others, has been noted and commented on in a number of reports to the Federal government. Major reports were made in 1965, 1968 and 1969. As a partial result of the foregoing, a Task Force on Earthquake Hazard Reduction was appointed by the Executive Office of the President through its Office of Science and Technology. The author of this paper had the privilege of being chairman of this Task Force.

It is not the purpose here to review in detail the recommendations which were given in the Task Force report. However, it is quite appropriate to briefly summarize what needs to be done. The following has been liberally quoted from "In the Interests of Earthquake Safety", authored by the members of the Presidential Task Force, and published by the Institute of Governmental Studies at the University of California at Berkeley.

1. Priority Programs for Federal Support

Some priority programs of earthquake hazard reduction are highly urgent, offer opportunities for substantial early benefits with little cost, and are particularly suitable for Federal encouragement and support. These include establishing and enforcing Federal standards requiring earthquake resistant design and construction of important publicly owned facilities, and of privately owned facilities built with direct or indirect Federal help. A Federal agency should also enforce adequate standards during the reconstruction period following a major earthquake. The Federal government should accelerate work on the mapping of earthquake geologic hazards in metropolitan areas, vigorously encourage strong-motion earthquake research, and conduct full-scale tests of structures at the Nevada atomic test site. The Federal government should help communities evaluate their rôles in hazard reduction, and take responsibility for a realistic overall plan for earthquake disaster response.

2. Some Governmental Tools for Hazard Reduction

Achieving the goals of all the other programs will depend on effective implementation and enforcement. Thus it will probably be necessary to devise some new governmental machinery for regulation and land use control. Financial incentives are needed to encourage high standards of design, and penalties can help discourage poor performance.

3. Urban Planning for Seismic Safety

Imaginative and prudent planning for urban land use and for public facilities can abate existing hazards and reduce those posed by future development. To be effective, good basic planning must be backed by appropriate governmental tools for implementation and enforcement.

4. Strengthening Basic and Applied Research

Intensified research efforts are needed on earthquake cause, frequency, and distribution. Geodetic research is needed to determine more accurately the distortions in the earth's crust that precede, accompany and follow major earthquakes. Research in engineering and design must be augmented substantially in furthering a basic objective: the development of better and safer structures that can withstand foreseeable future shocks.

Time and space do not allow a more detailed review of the apparent directions being taken by public policy in State and Federal earthquake hazard reduction programs. But, clearly, State and Federal involvement is expected to grow substantially in these programs, and quite possibly it may pre-empt local government where it has inadequately solved the problems.

TYPES OF CONSTRUCTION AND SPECIAL BUILDING STANDARDS

Eng. Ferlito and Eng. Cipollini

The memoranda will deal with the following aspects: provisions adopted in Italy with a view to regulating building activity in the Municipalities subject to intense seismic movements by dividing said Municipalities, or sections of them, into categories, in relation to the extent of seismicity and geological composition.

The information criteria of the new seismic law, and in general, the prevention aspect of earthquakes effects with suitable technical standards, which concern new constructions as well as repairs, rebuildings and elevations in the old built-up centers.

Investigations to determine the interventions necessary for reducing the dangerous character of the earthquakes in the centres made up mainly by old buildings.

Furthermore, engineer Cipollini will outline the following subjects: national seismic network (selection of stations and utilization of data); experiences of the effects of recent earthquakes on mural or reinforced concrete constructions. scientific research underway on seismic engineering.

"SEISMIC MAPS"

Dr. Peronaci

Within this year a seismotectonic map will be completed listing all earthquakes of the past two centuries. The map will consist of a number of tables, and has been worked out taking into account two fundamental principles:

(1) to place the seismic activity in relation with the geotectonic characteristics of the national territory in keeping with the recommendations and criteria agreed upon within the U.G.G.I. (Position of the focus with regard to the active faults, magnitude, intensity);

(2) to determine the maximum permissible intensity for each region and the wave frequencies so as to provide additional data to the problem of constructions in seismic zones.

In view of the striking geological and tectonic complexity of the Italian Peninsula, the elaboration is effected by breaking down the territories into 12 regions for each of which different formulas of correlation between magnitude, frequency and intensity had to be worked out.

This map is the first step towards reaching subsequent enlargements up to 500,000 and 250,000 for those zones featuring a high seismicity that will have to be more closely studied with microregionalization criteria.

PREVENTION OF EARTHQUAKES - RESULTING DISASTERS AND TECHNIQUES FOR DANGER REDUCTION

Dr. Peronaci

Reference is made to the program that has been under way for several years at the National Institute of Geophysics jointly with the Ministry of Public Works so as to reach more valid and modern standards for constructions in zones featuring high seismicity.

The program entails:

- a microseismic study of similar origin earthquakes, by using recordings of the natural network, as well as those of mobile stations which come into action in case of seismic events;
- a study of the behavior of active faults (accelerometer and clinometer stations);
- surveys on the coefficients of energy absorption and on the prevailing periods;
- determination of response and acceleration spectra by resorting to data obtained by the accelerometer network of the Ministry of Public Works now being set up. To this end, several recordings have already been obtained and the relative spectra have been calculated.

Lastly, mention is made of the criteria followed by the Commission of the Superior Council of Public Works aimed at reaching new standards which are to replace the conventional static force with the dynamic action of earthquakes on the building.

PLANNING AND ZONING FOR SEISMIC HAZARDS

A GENERAL PROPOSAL

by

E. Jack Schoop, AIP

In the past, planning for our cities has taken little note of ground conditions that might prove to be hazardous in the event of an earthquake. Geologists who were aware of such hazards and urban planners who plotted the future development of cities were virtually unaware of each other. The situation has only begun to change in the years following the 1964 great Alaskan earthquake when, for the first time, very large sums of money were expended for research into the causes of the extensive disaster. Thereafter, increasing attention has been focussed on the fact that geology, as well as building codes, needs to be considered in reducing the hazards from earthquakes. For, we have learned that even the most solidly constructed building cannot stand on ground that fails beneath it.

The role of planning and zoning in the United States

A note about planning and zoning in the United States. Here, urban plans are of an advisory nature even though they may be officially adopted by the city or county government under whose auspices the plan was prepared. American city plans are indirectly implemented by a variety of development programs and regulations; the foremost regulatory instrument is the zoning ordinance which, when adopted by the city or county, has the force of law in regulating what an owner may do with his property. Other means of implementing the plan are municipal action in redevelopment programs, and provision of public utilities, road and schools. It should be further observed, that political pressures and other circumstances will frequently cause a city to be developed in a manner different from that anticipated in its urban plans.

Urban planning for earthquake hazards

In the aftermath of the Alaskan earthquake, it was realized that we have painfully little scientific information about what happens to the ground during the violent shaking of an earthquake but also that we could substantially reduce future hazard by applying what we do know now.

We already know a fair amount about fault zones, unstable soils, and the behavior of steep slopes. Geologists can chart where these phenomena occur within the urban region. However, they cannot be categoric about the degree of hazard that might be involved because, of course, engineering solutions may be devised to satisfactorily overcome the hazard.

The land planner, working with the geologist, should consider the potentially hazardous areas as one of the numerous parameters of his planning. Together with engineers, they should identify areas for which some degree of seismic hazard can be anticipated and indicate what general precautions ought to be taken in view of the extent of hazard indicated. The findings and mapping will usually have to be fairly generalized because detailed exploration of all of the ground will seldom be feasible.

The planner, in making his plans, can then seek to avoid intensive urban development or the location of critical public facilities in areas where there is a fairly sure indication of major hazard that probably cannot be offset by engineering. In other hazard areas that have been indicated, he can note that the potential hazard exists and that special engineering should be considered for any development proposed in such areas.

A major consideration is the fact that our knowledge of potential seismic hazards is still fairly dim. For instance, it appears that the recent San Fernando earthquake in Southern California was caused by a vertical fault movement instead of the horizontal one that had typified most documented earthquakes in California; the resulting disturbance to the ground was very widespread, but apparently it is not very predictable. This may represent a kind of earthquake hazard which we might not be able to plan against; or, it might represent a new dimension that we should incorporate into our planning. In addition, the generalized concepts incorporated in the plan on the basis of the relatively sketchy information then available will be amplified over time by the engineering studies being done for construction in those areas, permitting a more definitive definition of hazard in future years. Therefore, the urban planner and the geologist should be in constant communication to monitor and implement the new knowledge that is rapidly forthcoming and that will continue to evolve over the coming decades. The urban planner's plan must be revised periodically to incorporate the results of the latest research and experience.

The next Step: Zoning

The typical American zoning ordinance stands by itself and does not make specific reference to the general plan that is supposed to be its foundation. The zoning ordinance consists of regulatory text defining uses that may be allowed in certain types of zones; the zoning map, which is part of the ordinance, divides the city or county into the several zones established by the ordinance.

The zoning ordinance could incorporate the findings and recommendations of the general plan concerning seismic hazard in several ways: (1) the different hazard areas mapped in a general plan could be incorporated on the zoning map as an "overlay" zone that would impose additional regulation beyond that already propounded for the basic zoning that it overlays, (2) if they are relatively few in number, the several hazard classifications could be incorporated with actual use zones (e.g., there might be separate "single family" zoning classifications for hazardous areas and for non-hazardous areas), and (3) geologic and engineering investigations might be uniformly required as a general condition throughout the city or county, eliminating the need for specific mapping of hazard areas. The choice of how recognition of the zoning hazard is incorporated into the zoning ordinance depends to some extent upon what is legally allowable ordinance construction and how varied the hazard might be throughout the city or county. For instance, if the whole city were in essentially the same hazard zone, a general investigation requirement in the text of the ordinance might well be sufficient, whereas in any area where there are a fair variety of distinct categories of hazard, the overlay zone would be most desirable.

What the zoning ordinance should require

As previously noted, the identification of potential seismic hazard is usually tentative pending more detailed engineering investigation or a particular site for a particular development. Since the zoning ordinance regulates the specific uses of the property, it should call for a competent soils engineering report for any development project proposed in an indentified hazard area. Depending upon the sophistication of the preliminary data about the hazard zone, the ordinance should specify an extent of engineering investigation that is appropriate to both the nature of the risk and the nature of the proposed use. For example, engineering requirements for uses involving large numbers of people should be much greater than for very low density uses such as a park or a warehouse area.

A major consideration, given the paucity of knowledge at this time and the varying degrees to which different engineers and geologists have acquainted themselves with it, plus their inherently different capabilities, is the quality of the city's or county's review of the engineering report for a particular development. In addition to continuing evolution of knowledge, a large degree of judgement is required in making recommendations for construction in hazard areas. Furthermore, it has been indicated that a number of different disciplines actually need to be involved in preparing and evaluating a report that is as competent as current knowledge can make it. The knowledge of geologists, soils engineers, engineering geologists, and structural engineers usually needs to be combined.

Therefore, it is recommended that the city or county create an inter-disciplinary board which can include these diverse talents. The board should develop criteria for the guidance of the engineers who will submit reports to them. In practice, because of the subjective nature of the individual problems, preliminary conferences with the project engineer are desirable to work out an understanding of the kinds of studies that should be undertaken for a specific project. The use of the board will not only raise new levels of confidence of the studies for each project but also will eliminate one frequent current frustration for the public official - the contradictory reports of several consultants - particularly if the board is composed of some of the most competent professionals in the city or region.

Given the relative shortage of talent in the field related to seismic hazard, a single board for a whole region or for a substantial parts of a region might well prove to be desirable, particularly if the nature of the seismic problems is fairly thinly spread among the cities and counties in the region. The working model for the board which I have described here is the Engineering Criteria Review Board which is performing the afore-described functions for my employer, the San Francisco Bay Conservation and Development Commission. It is composed of some of the most eminent professionals in the several fields in this country, many of whom are participating in this conference with you.

The final requirement on the zoning ordinance would be that any project that is approved be, in fact, constructed according to the recommendations of the board. For this purpose, competent inspectors will be necessary. Here again, a regional approach might be necessary both in order to lower the cost to the local government and to share the available talent as widely as possible.

Conclusion

The presumption of this paper is that hazard from earthquakes is to a large degree one that can be avoided. It also recognizes that knowledge about what constitutes seismic hazards is still relatively sketchy and general, but is nevertheless sufficient to enable us to avoid substantial future hazards. It proposes that the general hazard be recognzed in the urban planning process and that specific site investigation be required by municipalities under the auspices of an interdisciplinary board of competent professionals concerned with seismic hazard.

It is recognized that the proposed recognition of seismic hazard in future construction does not attack the substantial problem of existing urban development that we must now suspect to be dangerously hazardous in the event of a major earthquake. But, adequate recognition of seismic hazard in the *future* development is a first step necessary to create the understanding, support, and methodology for eventually dealing with the total problem.

PLANNING AND ZONING FOR SEISMIC HAZARDS

A SPECIFIC APPLICATION, PORTOLA VALLEY, CALIFORNIA

by George G. Mader, AIP
William Spangle & Associates, City & Regional Planners

The experiences of the Town of Portola Valley, California, illustrate one community's attempt to recognize seismic problems in its planning program. Portola Valley, a small residential community approximately 30 miles south of San Francisco, lies astride the well known San Andreas Fault. (Slide 1 - Aerial Photo of Portola Valley with San Andreas Fault shown.) The town covers approximately 10 square miles. Horizontal movement along this portion of the fault at the time of the 1906 San Francisco earthquake was about 6-8 feet. To the west of the fault, steep slopes rise 1600 feet to the crest of the coast range and to the east, less precipitous rolling hills rise 400 feet.

The general plan of the town, adopted in 1965, recommended a growth pattern for the next 20 to 25 years. (Slide 2 - Portola Valley General Plan). The plan calls for low-density residential development of approximately 2 acres per home site, with homes clustered on ridges and retaining the steep canyons as open space. When the plan was prepared, these steep canyons were judged too unstable and fragile for development. It should be remembered, the general plan is used in this country as a general policy guide and is not meant to be specific or detailed. When the plan was prepared, geologic information regarding the San Andreas Fault was not available in a form usable by the planners. Consequently, a situation not uncommon was found wherein rather high intensity uses were proposed along a fault. The plan did, however, propose steep canyons as open space which later proved to have unstable ground.

Three years later, the Town prepared and adopted regulations stipulating the uses that land could be put to and describing methods of subdivision and development. These regulations were the zoning ordinance, subdivision ordinance and grading ordinance. Through the efforts of keenly interested geologists living in the town and a specially created geologic hazards committee, these regulations included a number of provisions requiring geologic studies as a prerequisite to development of land. In general, these regulations require any developer to prepare detailed soils and geologic reports prior to approval of his plans. The developer is required to show how his plan conforms to the soils and geologic conditions and how he plans to solve potential problems which can be corrected.

Concurrent with the adoption of these ordinances, the town retained a town geologist. His job is severalfold and includes preparation of a geologic map of the town, advice to the town on the maintenance of a good geologic program, and finally, and perhaps most importantly, review of all proposed developments and attendant soils and geologic reports. The town geologist reports his recommendations to the town planning commission and town council which rely heavily on his expert advice.

Let us now review a proposed development on approximately 400 acres of land which came before the town recently. (Slide 3 - Aerial photo of Bovet Property). This property had long been thought to be one of the better pieces of land for development in the town due to its gently rolling topography, fine stands of oak trees, access to roads and proximity to an elementary school. The owner had thought for many years that this land would support a fine residential development with large lots distributed rather uniformly over the entire property. The town general plan set forth certain developmental policy for the property. (Slide 4 - Portion of Town General Plan for the Bovet property). The plan proposed a residential density of approximately 2 acres per dwelling unit, greenways along major roads and through a narrow valley, steep wooded hillsides preserved as open space and a clustering of residential development on the remaining areas. The plan is general in that the proposed use areas are not precisely defined and can only be defined through more precise planning as required by the zoning and subdivision regulations. The zoning and subdivision regulations set forth detailed requirements for soils and geologic reports, the design of the street system, the minimum sizes of lots, provision of utilities and many other development considerations.

The developer undertook the required soils and geologic studies at an early date as he thought these would be crucial in the design of the development. His geologist prepared two maps, one showing the geology of the land, the other the relative stability of the different geologic formations. These maps proved a revelation to the property owner and described serious limitations to the development of the land which he had not anticipated. At this stage of the planning process, geologic investigations were based on surface explorations with more detailed geologic work to be done at later stages in the planning and development process.

The geology map showed the eastern portion of the property to consist of relatively stable formations - Butano Sandstone and Franciscan - and areas with relatively thin coverings of slope wash. (Slide 5 - Geology Map). It was thought problems in this area could be handled through proper engineering design. The western portion of the property, however, included a large area covered by landslide debris and many landslide scarps. The map also identified three fault strands, one of which moved in 1906 and was deemed an active fault. This map was translated into a relative stability map, a map which was more meaningful to the engineers and architects designing the development and to town officials. (Slide 6 - Relative Stability Map). The map classified land into three categories: stable, potentially moving, and moving. These categories were based on the natural stability of the land, that is, in a condition undisturbed by man. In addition, the fault traces were shown. The applicant's geologist and the town geologist concurred that development should be designed to avoid the areas of deep landsliding, avoid bands 100 feet wide along the fault traces, and include careful design treatment for development on the areas of shallow landsliding.

The developer then prepared a development plan responsive to these geologic conditions as well as a host of other requirements of the town. (Slide 7 - Plan of Bovet Development.) The plan consists of small clusters of individual lots ranging from approximately 1/2 to 1 acre with substantial open areas to be owned in common and available to all the residents of the development. An important point here, is that the nature of the adopted general plan and the provisions of the regulations allowed the developer to use the good land and avoid the unstable land. The plan avoided the siting of residences on unstable and potentially unstable lands by leaving these areas as open space. (Slide 8 - Bovet Development Plan with Stability Overlay.) In this process, the developer was penalized only slightly for having land that had so many geologic problems. The final design had a yield within 2% of the maximum yield of dwelling units that would have been permitted had no geologic problems been present.

This amount of review and information still is not sufficient to permit development on the Bovet Property. As each portion of this large development is undertaken, the applicant will be required to perform sub-surface explorations to substantiate or modify the data based on surface exposures and to provide the data necessary for adequate engineering design.

This degree of recognition of geologic faults and unstable hillsides, while perhaps not new to some other countries such as New Zealand, is relatively new to this country and the San Francisco Bay region. To underscore this point, let us look at a preliminary subdivision design for the property we have just discussed which was prepared in 1956 but which was never submitted for official approval. (Slide 9 - 1956 Subdivision Plan with Stability Overlay). This plan proposed an almost even distribution of lots over the entire property paying absolutely no heed to geologic problems. In all likelihood, this plan would have been approved in essentially this form in 1956, if not even more recently.

This is but a brief review of what one small but enlightened community is attempting to do to recognize seismic and other geologic problems. The Town of Portola Valley sobered through witnessing landslides in the local area which resulted in large property losses, has decided that a sound planning program must recognize geologic hazards.

These experiences have also pointed out, however, areas in which we need substantially greater knowledge and experience in order to adequately deal with geologic problems. Some recommendations are:

1. We need to determine what kind of geologic data is needed at each of the different geographic or governmental levels and also at the different stages in the development process. For instance, we need to know what kind of information is needed to plan for the San Francisco Bay Area region versus the kind of data necessary to plan for a small city. We need to know what kind of information is needed to make general decisions for developing large residential areas versus the kind of information needed for constructing a home on a given plot of land.

2. We need to determine the appropriate role of each level of government from the federal to the local level in applying geologic data in the land use decision-making process. We need to define these roles in terms of guidelines, administrative requirements and legislation.

3. We need to learn how to measure the amount of risk inherent in any given combination of potentially unstable land and any given land use. For instance, we need to know the comparative risk between construction of a single-family frame residence next to an active fault versus the construction of a market or a school. We must be able to define acceptable levels of risk to protect the public and private interests.

These are a few of the many tasks warranting our best collective efforts. The partnership between geologists and planners has only recently begun in this country. Experience in recent years, however, points out that further cooperation between geologists and planners can result in far improved physical environments for man.

URBAN PLANNING AND LAND ZONING

Abstract from statements by
Lloyd Cluff Woodward-Lundgren & Associates

Urban planning and land zoning must take the various geologic factors that influence seismic risk into account at a very early stage. The seismic risk problem is not a simple question of either planning or designing for complete protection or ignoring the problems altogether. From the point of view of society, neither of these alternatives is acceptable. To establish an acceptable, efficient, and practical solution requires a greater knowledge of the geologic hazards and their potential effects on works of man. This must be followed by interdisciplinary evaluations involving geology, engineering, and planning.

Many variable factors influence the degree of risk that may be associated with urban development within seismically active areas. These variables include geologic factors and land-use factors such as site or building occupancy, building height, structural system, and quality of construction.

It may be desirable to develop maps showing risk zones based on primarily geologic factors. It is then possible to develop land-use planning recommendations for land and building uses in various risk zones. To accomplish this, it is necessary to consider the following factors:

(1) the probable types of geologic risks, such as fault rupture, ground shaking, liquefaction, lateral spreading, and tsunamis;

(2) the ability to identify land areas where these types of geologic risks are possible;

(3) the ability to assign either qualitative or quantitative limits on the effects of these risks;

(4) the types of land and building uses and their socio-economic importance;

(5) the behavior of buildings and other improvements under seismic conditions.

Information will be presented from several case studies to illustrate the concepts that must be understood in order to provide practical and meaningful urban planning and land zoning in seismically active regions.

CCMS No.9

RESPONSE TO GEOLOGIC HAZARDS OF EARTHQUAKES

by

Robert E. Wallace

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It is axiomatic to say that the hazards of earthquakes stem from the "misbehavior" during an earthqauke of the ground on which we build and live. The nature of this "misbehavior" has been greatly misunderstood by many of those responsible for the administrative and technical decisions to reduce earthquake hazards. Furthermore, the state of earth sciences in its capability to specify the ground "misbehavior" quantitatively still leaves considerable to be desired. Nevertheless, what is known by earth scientists can be of great help in reducing the hazards.

The earthquake behavior of the ground can be considered in four categories:

(1) ground shaking;

(2) ground failure, including landsliding, cracking, differential settlement and liquefaction;

(3) surface faulting, and

(4) tectonic change, i.e., gross level changes of large regions.

Hazard reduction methods for coping with these four categories of ground behavior include:

1. For ground shaking - improvement of engineering design and practice, and the expression and regulation of these through building codes. Land zoning can be used to refine codes in recognizing the relation of shaking to local geology as quantification of that factor is improved.

2. For ground failure - land-use zoning techniques should be the primary response to these hazards, because engineering techniques commonly cannot cope with these problems economically. These hazards have been largely ignored but may actually exceed shaking as a hazard.

3. For surface faulting - risk-zoning and land-use planning can be very effective in reducing this hazard because of the strong tendency for many faults to break repeatedly on the same strand or branch.

4. For tectonic change - the main hazard occurs at a water-land interface, e.g., harbors and port facilities. The recognition and definition of potential land-level changes will suggest engineering responses such as dikes around critical facilities. Damage to biota - e.g., oyster beds - also may result from level changes.

The reduction of hazards will depend upon continued efforts to improve:

(a) the quantitative definition of geologic hazards through research and risk mapping;

(b) response to these hazards through improved engineering design and practice;

(c) improvement of regulatory and guidance techniques including codification and land-use planning; and

(d) disaster response techniques. None of the response techniques, however, can be entirely effective unless a very real idea is in hand of the possible, probable, and credible events created by an earthquake.

BUILDING CODES AND SPECIAL CONSTRUCTION ORDINANCES

by

Henry Degenkolb, Structural Engineer,
San Francisco

Mr. Degenkolb states the necessity of adapting building codes to earthquake hazards.

CCMS No. 9

TSUNAMI HAZARD EDUCATION: REPORT OF A PILOT STUDY

Abstract from a statement by J. Eugene Haas

Any disaster warning system has many links in the communication chain. If injury and loss of life are to be minimised, all of the links must function adequately during the crucial time period so that citizens in the hazard zone will receive the warning message promptly. But there are three equally critical elements which are frequently overlooked. The citizen must be able to interpret the warning message correctly, know the appropriate actions to be taken, and he must be motivated to take those actions.

An experimental tsunami hazard public education program was conducted as part of a research effort on the effectiveness of the tsunami warning system in Alaska. The experimental education program is described and the consequences are evaluated. Aternative solutions to the "citizen response" problem are discussed.

SEISMIC RISK MAPPING IN THE UNITED STATES

S. T. Algermissen and L. M. Murphy

ABSTRACT

Progress on seismic risk mapping in the United States is reviewed. The three critical factors in risk mapping are: (1) seismicity, (2) the response of local surficial geology to seismic waves, and; (3) regional geologic features and tectonic features related to seismicity. These factors are discussed and current research work is outlined. The form and content of a more advanced type of risk map are outlined.

DISASTER, PREVENTION AND HAZARD REDUCTION

R.J. Williams

The earthquake of 9th February, 1971, that shook the Los Angeles and surrounding areas had a rating of 6.6 on the Richter scale. The intensity of accelleration in the Sylmar and surrounding areas was probably as high as any that will be experienced in California. A reading adjacent to the Pacoima dam showed an accelleration of 102% which is the highest ever recorded in an earthquake. Fortunately the earthquake was localized and of relatively short duration, otherwise, it could have had a reading above 8. This earthquake had unique application in that it occurred in a metropolitan area and was the best documented earthquake to date. It was an excellent test of modern construction and building codes. It varied from an intensity higher than had previously been expected and decreased in the southern limits of the city to where no structural damage was noticed.

In general terms the one story wood frame dwellings performed in an excellent manner with only two partial collapses in the city. The high rise buildings in the downtown area approximately 20 miles from the area of high devastation had only negligible damage. While these high rise buildings were performing so well, older buildings in the same area that were built previous to earthquake design requirements were beginning to fail with 136 having to be vacated. Wood frame buildings two stories or more in height and some other buildings of modern construction showed a nominal amount of damage indicating that certain features in today's building codes should be reviewed. Our latest information indicates that within the city of approximately 750,000 buildings, there were 766 buildings vacated as being unsafe, 3,500 with major damage and 21,000 with minor damage. Considering the high intensity of the earthquake the conclusion is that modern design, construction, and code requirements performed in an excellent manner.

Buildings within the city were first required to be designed for earthquake in December 1933, following the Long Beach-Inglewood earthquake that claimed approximately 120 lives. In 1960 the design requirements were modified to provide for a pseudo dynamic application of earthquake forces. These same code revisions were adopted by other jurisdictions and are now applied on a wide basis. The City of Los Angeles, in 1947 required buildings built prior to December 1933, to have masonry parapets and appendages removed with walls anchored to the roofs to reduce the earthquake hazards in these old buildings. This program is now virtually completed and undoubtedly kept the casualty list from being much higher. Other city code provisions require light fixtures to be earthquake resistant, windows to be framed in resilient mountings to prevent shattering above the first floor and in 1965 required accelleographs to be installed in new buildings more than six stories in height.

The total death toll of 65 shows that of these 45 were in an older Federal hospital that was not designed for earthquake, 9 heart attacks, 2 were bridge failures and only 3 were due to building failures within the city, another 4 in county buildings and 2 miscellaneous.

Immediately following the quake the city departments were able to handle most of the emergency operations for police, fire, building inspection and water and power. The smaller city of San Fernando which had a higher percentage of older buildings had to rely on help from other agencies. The availability of helicopters by the city greatly expedited quick service and co-ordination. The pre-planned disaster plan also greatly aided in the emergency situation. Relief help such as Red Cross, Corps of Engineers, Office of Emergency Preparedness and others were of vital importance in helping to provide immediately to care for the displaced, injured, and distressed persons and in the clean-up and reconstruction period.

It is difficult to provide urban planning and land zoning relative to earthquake inasmuch as the prediction of locations of future earthquakes and date of occurrance is not practical at this time. Greater research and possible new development in earthquake amplification areas would be highly desirable and may aid in planning and zoning provisions.

RECOMMENDATIONS:

1. There should be a universal requirement for the more important buildings to be designed by a professional engineer or architect under construction code requirements.

2. Emphasis should be placed on additional research and study in seismic geology with high emphasis on seismic amplification or magnification.

3. Programs for corrective work on existing buildings not designed for earthquake should be established.

4. Planned community disaster programs should be required.

5. An acceptable level of risk factors should be developed.

6. Requirements of greater protection on vital facilities needed for disaster operations should be made.

7. Current code construction and design requirements should be revised for those failures observed.

GENERAL INFORMATION ON ORGANIZATION AND ACTIVITIES
FOR
EARTHQUAKE DISASTER RESPONSE IN TURKEY

by Alkut Aytun,

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INTRODUCTION

Anatolia has been an earthquake country throughout its history. Many settlements in various parts of Anatolia, have been destroyed by earthquakes, some several times. It is on the Alpide belt, which is responsible for the 15% of the world's destructive earthquakes(1).

Geological investigation shows that the land is marked through by active tectonic zones, and earthquakes happen for many millions of years.

The North Anatolian Fault Zone exhibits an especially interesting feature, which provides a field laboratory, where tectonic movements can frequently and clearly be observed, under quite suitable conditions. This zone has a series of ground fractures, where the chain of mountains join the valleys accomodating major rivers, flowing almost in east-west direction. As those rivers provide the required irrigation to the surrounding land, the valleys are mostly fertile agricultural areas with a population density higher than that in the mountainous areas. Lower parts of the chain of mountains offer a good route for highways, railways, energy and communication lines. So the regions exposed to periodical violent ground motion throughout the history, have always been the densely populated and important portions of the land, resulting in loss of life and damage, and in many cases, disasters.

The situation is not much different in the earthquake zones other than that of North Anatolian. In Western part of Turkey, several parallel active graben areas, trending in east-west direction, accomodate major rivers. The similar results, in view of loss of life and damage, can be observed, although the tectonic characteristics are quite different.

The blocks on each side of the North Anatolian Fault Zone, perform a relative movement, laterally and vertically. Lateral movement is right-handed and Northern moves down, in general. But the grabens exhibit mainly vertical movements, the portion in between moving down. Almost all of the destructive earthquakes occur on these two zones.

The mentioned characteristics of the settlements, cause some more indirect damage in addition to that of earthquakes. Thick alluvium layers and high underground water table, which are common aspects of the preferred settlements, are generally known as factors, increasing the rate of damage. The tectonic movements trigger or accelerate such phenomena as landslides and rockfalls. A considerably large area along the river courses within the mentioned earthquake zones, are apt to be exposed to flood disaster.

As a result, the areas of high seismicity, are almost equally subjected to the risk of other forms of disasters (flood, landslides, rockfall, avalanche etc.). Those facts make to deal with earthquake zones, quite a complicated task. It can be easily understood that the post-earthquake activities have to be many-sided.

PAST GREAT EARTHQUAKES IN TURKEY

In the following list, the important earthquakes of this century are given to visualise the severity of earthquake problem. It can be seen that, almost each year a destructive earthquake takes place.

No. (x)	Locality	Date	Epicentral Intensity (MM)
1	Malazgirt	19. 4.1903	IX
2	Murefte	8. 8.1912	X
3	Burdur	3.10.1914	IX
4	Torball	31. 3.1928	IX
5	Marmara Isl	4. 1.1935	IX
6	Kirsehir	19. 4.1938	IX
7	Dikili-Bergama	21. 9.1939	IX
8	Tercan	21.11.1939	IX
9	Erzincan	28.12.1939	XI
10	Develi	20. 2.1940	IX
11	Bigadic	15.11.1942	VII
12	Erbaa	20.12.1942	X
13	Adapazari	20. 6.1943	IX
14	Kargi-Ladik	27.10.1943	IX
15	Erbaa	26.11.1943	X
16	Bolu-Cerkes	1. 2.1944	X
17	Edremit	6.10.1944	IX
18	Van	28. 6.1945	VI
19	Denizli-Buldan	21.12.1945	VII
20	Varto	31. 5.1946	IX
21	Cerkes	13. 8.1951	IX
22	Hasankale	31. 1.1952	VII
23	Adana-Misis	22.10.1952	VIII
24	Yenice-Gonen	18. 3.1953	X
25	Karaburun	2. 5.1953	VII
26	Edirne	18. 6.1953	VI
27	Soke	16. 7.1955	VI
28	Eskisehir	20. 2.1956	IX
29	Marmaris	25. 4.1957	VII
30	Abant-Akyazi	26. 5.1957	IX
31	Inegol	2. 4.1959	VII
32	Marmaris	23. 5.1961	VII
33	Igdir	4. 9.1962	VIII
34	Balikesir	14. 9.1962	VII
35	Denizli-Buldan	11. 3.1963	VII
36	Tefenni	22.11.1963	VII
37	Divrik	14. 6.1964	VIII
38	Manyas	6.10.1964	IX
39	Varto	19. 8.1966	IX
40	Adapazari	22. 7.1967	IX
41	Pulumur	26. 7.1967	VI
42	Bartin	3. 9.1968	VIII
43	Demirci	23. 3.1969	VI
44	Alasehir	28. 3.1969	VII
45	Gediz	28. 3.1970	IX

Although earthquakes caused great harm for many years, interest and studies on this phenomena started only after the great Erzincan earthquake of 1939. The most disastrous earthquakes after 1939, and the resulted loss of life and property, are listed as follows:

Locality	Date	Loss of Life	Dwellings Destroyed
Erzincan	28.12.1939	40,000	135,000
Erbaa	20.12.1942	3,000	32,000
Erbaa	26.11.1943	4,000	40,000
Bolu-Cerkes	1. 2.1944	4,000	50,000
Van	28. 6.1945	300	2,000
Manyas	6.10.1964	23	5,500
Varto	19. 8.1966	2,500	20,000
Adapazari	22. 7.1967	86	7,100
Pulumur	26. 7.1967	97	1,000
Bartin	3. 9.1968	26	260
Alasehir	28. 3.1969	41	2,500
Gediz	28. 3.1970	1,086	15,000

It can be said that, 60,000 casualties and a loss of property of $600,000,000 (US) approximately were caused by earthquakes, since the beginning of this century.

EARTHQUAKE ZONING MAP OF TURKEY

The studies to make the first earthquake zoning map of Turkey, have been initiated after the great Erzincan earthquake of 1939. The map was completed in 1945 and promulgated by the Ministry of Public Works. This map has been revised several times, and sometimes was accompanied by a list of cities and towns (1948, 1949, 1961 and 1963). The existing map, in use now is of 1963. With this map, Turkey has been divided into four zones, according to the observed maximum intensities and proximity to the fault zones.

Recently the work to improve the zoning map, by the Ministry of Reconstruction and Resettlement, is completed. The new map has been prepared, adopting the principles, suggested by UNESCO 1964 Paris Meeting. It distinguishes five zones, with respect to a combination of factors, some of them being: map of epicenters, observed maximum intensities, return periods of intensities equal to or greater than VII, seismic energy release, seismo-tectonic features, etc.

REGULATION FOR CONSTRUCTION IN EARTHQUAKE ZONES

The conditions to be realised for construction in earthquake zones are given in this regulation. The first regulation of this kind in Turkey, has been prepared by Ministry of Public Works in 1940, after the impetus of

Erzincan (1939) earthquake. It has been revised six times up to now (1944, 1948, 1949, 1953, 1961, 1968). The one that is in effect now, is of 1968. The major improvement in this, is the adoption of dynamic approach in obtaining the design earthquake forces. Each zone in the map is associated with a horizontal coefficient in the regulation.

Although the map and the regulation cannot be claimed as perfect, it is clear that observing the rules will, in great extent, reduce the loss of life and property. Control and supervision are of vital importance in this respect.

DISTRIBUTION OF LAND AND POPULATION WITH RESPECT TO EARTHQUAKE ZONES

Basing on the existing "Earthquake Zoning Map of Turkey", and 1965 population census, the land and population of Turkey, are distributed into earthquake zones as follows:

Earthquake Zone (x) (degree of seismic risk)	(sq.km)	(sq. miles)
I	134,857	52,068
II	212,110	81,892
III	99,847	38,551
-	327,996	126,637
TOTAL	774,810	299,148

(x): Zone I has the highest risk - is considered free of danger.

Earthquake Zone (x) (degree of seismic risk)	Urban population	Rural population	Total population
I	2,807,462	4,676,921	7,484,383
II	3,773,483	5,559,358	9,332,841
III	974,058	3,138,034	4,112,092
-	3,250,813	7,211,289	10,462,102
TOTAL	10,805,816	20,585,602	31,391,418

Finally, population and land area percentages of earthquake zones, are given in the following table:

Earthquake Zone (degree of seismic risk)	Land percentage	Population percentage
I	17.4%	23.8%
II	27.3%	29.7%
III	12.9%	13.1%
-	42.3%	33.3%
TOTAL	100. %	100. %

It can be concluded that 45% (or ½) of the country is exposed to serious seismic risk, and 53% (or ½) of the population are under serious earthquake danger.

The above figures impose Turkey to be aware of the earthquake hazard and to take measures to prevent loss of life and to minimize loss of property.

IMPORTANCE AND NATURE OF DISASTER RESPONSE ACTIVITIES

It is the goal of every earthquake-prone country, to provide permanent protection against the effects of the earthquakes. But no country can claim that this is fully reached. Every year destructive earthquakes occur and cause thousands of loss of life. In Turkey, where most of the local types of construction are not earthquake-resistant, post-earthquake activities must be effective in order to prevent the expansion of the disaster.

The most distinguished feature of post-disaster activities, is the urgency. As life and health are concerned, rapid measures must be taken. If the disaster affects the life of the general public, the local economy usually is not able to recover itself. The local authorities are also affected by the earthquake, so the national authorities must be engaged. In Turkey, the settlements are spread around and transportation poses a serious problem. Dealing with post-disaster affairs, requires great effort and initiative, within the frame of the legislation. Involvement and support of national, even international agencies are needed, depending on the scale of the disaster. Much depends on the efficacity of the plans to be prepared in advance.

SCOPE OF EARTHQUAKE DISASTER RESPONSE ACTIVITIES

The most urgent need, after a settlement has been stricken by earthquake, is for rescue and relief. Although it is very well known there are concrete examples from recent earthquakes that the urgency and keenness in this respect, can save considerable number of lives (Gediz Earthquake).

Other groups of activities can be put under the names: "Investigation and Evaluation of Damage", "Temporary Housing", "Permanent Housing" and "Public Facilities". These can be divided into sub-divisions.

LEGISLATION FOR NATURAL DISASTER RESPONSE

The earthquakes have affected the settlements in Anatolia in historical times. There are examples from Hellenic, Hittite, Seljuk, Byzantine and Ottoman civilizations, that important settlements were damaged. There are also quite a number of records on the post-disaster activities in damaged cities and towns (e.g. Istanbul Earthquake of 1509). The comprehensive activities of government response started only after the great Erzincan Earthquake (27th December, 1939), that killed 40,000 people and destroyed 29,000 dwellings. This earthquake raised the attention of governmental and technical authorities, in great extent. The parliament passed a special legislation (Act No. 4263) for aid to the survivors of the Erzincan Earthquake. The earthquake disaster activities following this event, were administered within the provisions of Acts Nos. 6409, 6610, 6683 and 7010, each for an individual earthquake. The Ministry of Public Works was of primary concern in reconstruction, although other Ministries were involved in other aspects. In 1958, the Ministry of Reconstruction and Resettlement was established, with the Act No. 7116, and the activities on disasters were transferred to the new Ministry. A more comprehensive Act (No. 7269) came into effect in 1959. It was amended by Act No. 1051, in 1968, which is still in effect. A rough outline of this Act is given in Appendix I.

Five regulations are applied to administer the detailed activities, in conjunction with Act No. 7269-1051:

1. "Regulation On The Criteria To Determine Whether A Natural Disaster Affects The Life Of The General Public."

2. "Regulation On Emergency Aid Organization And Programs, Related To Natural Disasters."

3. "Regulation On The Criteria To Be Used In Determination Of The Individuals To Be Aided."

4. "Regulation On The Reduction From The Cost Of Buildings Or Amount Of Indebtment, Within The Frame Of Post-Disaster Reconstruction."

5. "Regulation On Procedures Of Expenditure Out Of The Fund, Provided By The Act No. 7269-1051."

ORGANIZATION FOR DISASTER RESPONSE

The post-earthquake activities were administered by the Ministry of Public Works, until the establishment of the Ministry of Reconstruction and Resettlement (1958). In 1965, the General Directorate of Natural Disaster Affairs was established, within the Ministry. After the Varto (1966) Earthquake, an "Executive Board For Earthquake Regions" was established. This is considered a temporary board, and broad powers are given to the General Directorate of Natural Disaster Affairs, being the main institution for post-disaster response.

EMERGENCY AID ACTIVITIES

It is clear that emergency activities cannot be planned after the disaster has occured. The planning activity is performed in advance, as shown in the Paragraph 4 of Act No. 7269-1051, and in accordance with the "Regulation On Emergency Aid Organization And Programs Related To Natural Disasters". The main burden is on "Provincial Rescue and Relief Committees" to be established by Governors. Civil Defence Code (No. 7216), has parallel provisions, with respect to emergency activities, their planning and implementation. Governors have been given enormous powers and initiative for those activities. Co-ordination of powers of all institutions, charging the persons responsible with certain duties, diverting the vehicles or instruments to be used, and purchasing the required materials can be given as examples. For execution of these powers, it is not necessary to wait for the declaration stating that the disaster affects the life of the general public.

Immediately following the Gediz (28th March, 1970) Earthquake, the above mentioned committees were established in the provinces and towns. A central committee was also established by the following authorities:

Undersecretary of Ministry of Domestic Affairs.

Undersecretary of Ministry of Public Health.

Undersecretary of Ministry of Reconstruction and Resettlement.

Head General of Turkish Red Cross Association.

The following sub-committees were established in the affected cities and towns:

1. Emergency rescue and ruin removal sub-committee.
2. Tent distribution and accommodation sub-committee.
3. Health affairs sub-committee.
4. Food distribution sub-committee.
5. Sub-committee for evaluation of damage.

additionally, security, economic, social and employment and fuel measures were taken.

PREPARATION FOR PERMANENT HOUSING

The main objective of the post-disaster activities, is the permanent housing. The preparatory stage for permanent housing, can be divided as follows:

- "Determination Of Individuals, To Be Aided".
- "Provision Of Settlement".
- "Provision Of Technical Assistance".
- "Allocation Of Building Materials".

INVESTIGATION AND EVALUATION OF DAMAGE

Investigation of the affected area is done by the Earthquake Research Centre of the Ministry of Reconstruction and Resettlement. As earthquakes are considered a full scale vibration test of structures and facilities, the damaged and undamaged structures are studied. The Universities and other research institutions also co-operate in the investigation. There have been cases of co-operation with UNESCO and foreign experts, in this subject.

Other Ministries too, conduct investigation for their own purposes, e.g. Ministry of Public Works for schools and other official buildings, State Waterworks for water facilities etc.

Evaluation of damage, provides basic knowledge to assess the extent of loss of property, and is a major step for repair and construction activity. It also provides basis for the declaration of the disaster, as affecting the life of the general public.

The classification is as follows:

- No damage.
- Light damage.
- Moderate damage.
- Heavy damage.
- Destroyed.

DETERMINATION OF THE INDIVIDUALS TO BE AIDED

The term "individual to be aided" means the individual who can claim to receive aid for new housing, depending on the Act No. 7269-1051. "The Regulation On The Criteria To Be Used In Determination Of The Individuals To Be Aided" shows in detail, the procedures to be followed for this purpose. The regulation indicates the solutions of any problems that may arise, such as withdrawal etc. An outline of this regulation is given in Appendix IV.

PROVISION OF NEW SETTLEMENTS

Unless another disaster is considered probable and/or the present settlement is objectionable, the reconstruction activities are performed on the same settlement. Otherwise a new location is selected. Usually the governing factor is the comparison of the cost of preserving the location with preventive measures, and the cost involved for moving to a new location. Paragraphs 16 through 26 of the Act No. 7269-1051 bring provisions on this subject.

The Department of Geological Investigation (of the General Directorate of Natural Disaster Affairs) carries out the required geological and soil studies for settlements. Recently the importance of microzoning is realised and the new settlement for Gediz town is studied from this point, to guide town planners.

ALLOCATION OF BUILDING MATERIALS

It is essential to provide building materials in sufficient quality and quantity, to complete the construction activity without delay. Especially timber, reinforcement bars and cement are the materials subject to allocation from the sources. The allocated materials cannot be used for other purposes.

CONSTRUCTION ACTIVITIES

Construction in the damaged area is the final activity. Usually one of the following three methods are used:

- Construction bids.
- Department construction.
- Aided self-help.

The first and second methods can only be used for housing in large numbers. In the second method, the Ministry of Reconstruction and Resettlement constructs itself through its own organization and staff. In this case too, parts of the work can be given to constructors.

Aided self-help method envisages the co-operation of the individual and the state. The individual is provided with technical and administrative assistance, and the loan is delivered in instalments. The preparatory services are also provided by the Ministry. Experience has showed that this method is very useful in various respects, but introductory training is essential at the beginning.

PUBLIC FACILITIES AND SERVICES

Although the term "public facilities" has a broad meaning, here only the following are referred: roads, water, electricity and sewage. In this frame, public facilities can only be provided for the settlements, experienced a natural disaster, affecting the life of the general public. The Ministry provides the necessary network and connections. The work can be transferred to municipalities and other public institutions, such that the expenses be provided by the Ministry.

Expenditures for mapping, reconstruction planning, designing, public facilities etc. are not included in the cost of dwellings, provided to the individuals.

The individual reimburses the amount within 20 years, without interest. In certain cases, reduction as much as 50% can be made. The conditions for the reduction, are given in the "Regulation On The Reduction From The Cost Of Dwellings Or Amount Of Indebtment, Within The Frame Of Post-Disaster Reconstruction". A rough outline of this, is given in Appendix V.

The individual is also exempted from various taxes, following a disaster, affecting the life of the general public. Annuation of debts is also provided in certain cases. The Act No. 1319 on Real Estate Tax, Act No. 1318 on Finance, and Paragraph 42 of the Act No. 7269-1051 have provisions on exemption.

ON THE VALUE OF HISTORICAL RECORDS OF EARTHQUAKES

by N.N. Ambraseys

(See pages 6-1 to 6-9)

DE LA VALEUR DES RAPPORTS HISTORIQUES SUR LES TREMBLEMENTS DE TERRE

par N.N. Ambraseys

(Voir pages 6-1 à 6-9)

La législation italienne pour les constructions dans les zones sismiques

La législation italienne actuelle, par rapport aux dispositions pour les travaux de construction, et comportant des prescriptions particulières pour les zones sismiques, a été émanée en 1962 et est formée de deux parties.

La première contient les normes techniques générales, applicables dans tout le territoire national et, par conséquent, aussi dans les localités sismiques; la seconde contient des normes particulières, dont l'application est obligatoire seulement dans les Communes, ou dans leurs parties, qui en relation à leur degré de sismicité et à leur formation géologique, sont comprises dans les listes spéciales et divisées en deux catégories.

On a voulu, ainsi, disciplinaire selon un plan le territoire tout entier, dans le but, soit d'avoir une vision globale en ce qui regarde la marche du phénomène dans les différentes régions italiennes, soit, et surtout, pour que dans les zones reconnues sismiques de I^{e} et II^{e} catégorie, soient appliquées toutes les prescriptions dont il a été question précédemment.

De cette division en zones est née la carte sismique d'Italie, grâce à laquelle on reconnaît facilement que la partie plus fréquemment et plus intensément sujette aux mouvements sismiques, est la région centrale et méridionale, comprise dans une vaste bande sismique, qui partant du Maroc, traverse l'Italie, la Grèce, et la Turquie, pour terminer au Golfe Persique.

La réglementation a été établie pour proportionner d'une part toute cette délicate matière aux progrès de la science et de la technique, et renforcer d'autre part, les sanctions civiles et pénales par l'observance de ses prescriptions, dictées, naturellement, pour la sauvegarde de l'intégrité publique et privée.

Etant donné la longue et malheureusement triste série de crises sismiques qui ont ravagé l'Italie dans ces soixante-dix dernières années, on a eu la possibilité de constater comment les constructions faites selon les données de la technique, ont validement résisté aux sollicitations dérivant des secousses sismiques.

Toutefois, tous les règlements qui se sont succédés en Italie, depuis le jour où le problème sismique s'est posé, ont toujours ressenti le manque de données instrumentales de relèvement. La question a été résolue dans le passé en adoptant une réglementation plutôt rigide et sévère, surtout par rapport à la hauteur des édifices, le manque de données précises rendant extrêmement prudent le législateur, puisqu'il s'agissait de sauver des vies humaines.

En outre, aux limitations de hauteur des édifices, on apposait un calcul peu compliqué de structures à châssis, sujettes à des forces conventionnelles horizontales.

La nécessité d'une nouvelle réglementation pour les constructions dans les localités reconnues comme sismiques, a été sentie peu de temps après l'émanation de la législation en vigueur, et cela parce que le progrès de la recherche scientifique sur ce sujet a mis davantage en évidence la disproportion des lois actuelles.

Tout ceci a eu un effet nettement déprimant sur le développement des régions déjà les plus déprimées de notre territoire national, étant donné que ces régions figurent parmi celles qui sont les plus touchées par les mouvements sismiques.

Cette nécessité s'est montrée encore plus urgente à la suite du mouvement sismique qui a touché en janvier 1968 la Sicile occidentale, détruisant complètement les centres de Gibellina Montevago, Salapacula et d'autres.

C'est pourquoi, le Ministère des Travaux Publics a constitué une Commission chargée de formuler une réglementation technique pour les constructions en zone sismique, qui substituera la réglementation actuelle.

Cette Commission, au cours de ses travaux, a retenu opportun de ne pas limiter ses soins à une révision des lois en vigueur, mais elle a prédisposé un programme de travail pour un temps plus long, afin de préparer, soit même en phases successives, des règles techniques répondant aux recherches scientifiques les plus récentes en la matière et sur la base des plus importants relèvements sismiques.

Le problème pourra être affronté seulement après avoir doté l'Italie d'un réseau complet de stations "accélérométriques", aptes à fournir les données nécessaires pour la préparation d'une réglementation moderne.

Il n'était, pourtant, pas possible d'attendre si longtemps les données qu'aurait fourni le réseau, à cause du temps assez long qui caractérise la répétition dans une même localité de l'activité sismique.

On a remédié à ceci en utilisant temporairement les données obtenues par l'étude des tremblements de terre du monde entier et en particulier de ceux de la Californie.

On a analysé pour cela les "sismogrammes" disponibles (une centaine environ) relevés dans différentes zones de la surface terrestre.

Pour faire cela, selon l'état actuel des connaissances, on a retenu que le coefficient sismique par rapport à un certain édifice d'un certain type de construction et, par conséquent, d'une certaine ductilité, peut dépendre avec une approximation suffisante de deux grandeurs seulement: la période et le coefficient d'amortissement du premier mouvement de vibration.

Les registrations qui ont été analysées (environ soixante) ont été réunies en trois groupes.

Le premier comprend les registrations des tremblements de terre californiens, sur lesquelles sont basés les critères des projets les plus répandus.

Le second groupe de tremblements de terre regarde encore la Californie et renferme des phénomènes ayant des caractéristiques particulières en ce qui concerne la durée et la distance de l'epicentre. Les "accélérogrammes" ont enregistré quelques unes des accélérations les plus élevées qui se sont vérifiées durant les mouvements sismiques.

Les tremblements de terre du troisième groupe ont été observés en d'autres pays: ils présentent des caractéristiques très différentes entre elles. Les mouvements sismiques de Lima et de Koyona, en effet, sont caractérisés par une forte contribution de grande fréquence, tandis que ceux de Mexique ont comme caractère propre la presque totale absence d'une fréquence supérieure à un cycle par seconde.

L'ensemble de ces trois groupes de registration peut être considéré représentatif pour une vaste catégorie de mouvements sismiques éventuels.

Des études faites sur ces différents mouvements terrestres on a pu déduire que pour des structures rigides, et précisément pour des structures ayant une période propre inférieure à huit dixième de seconde, il ne convient pas de choisir une fonction quelconque - coefficient sismique/période - en l'absence d'informations sur les grands mouvements sismiques italiens.

C'est pourquoi, pour des structures rigides on a retenu opportun d'effectuer le choix d'un coefficient sismique précautionnel et non lié à l'analyse dynamique de la structure.

Pour ce qui regarde des valeurs d'une période supérieure à huit dixième de seconde, on a cherché une relation entre le coefficient sismique et la période, sur la base des "occillogrammes" observés.

Pour ce qui se rapporte aux "effets de coupe" qui se présentent aux étages les plus élevés des édifices, on a adopté le critère suivi par l'"Uniform Building Code", qui prescrit d'augmenter convenablement la force qui agit à l'étage supérieur et de distribuer le reste de cette force aux autres étages.

Quant aux limitations de hauteur encore prévues dans les nouveaux règlements, en phase d'élaboration avancée, il est à remarquer que celles-ci se rapportent uniquement aux édifices à panneaux portants et à ceux en maçonnerie.

Ceci parce que:

- pour les premiers, il n'a pas encore été acquis une expérience suffisante par rapport à leur comportement sous l'action sismique et il est, par conséquent, raisonnable d'observer un certain degré de prudence -
- pour les seconds, la limitation de leur développement vertical est né d'un comportement peu propre de ce genre de structure sous l'action sismique.

Les propositions de la susdite Commission ont été soumises à l'examen du Conseil Supérieur des Travaux Publics qui a exprimé un avis favorable et elles formeront l'objet pour la demande d'une nouvelle réglementation plus conforme aux progrès de la science et de la technique.

SCENARIO FOR THE SAN FERNANDO, CALIFORNIA EARTHQUAKE

From US Department of Commerce National Oceanic and Atmospheric Administration

An earthquake has occurred approximately two hours ago at 07:32 local time in the San Gabriel Mountains about 20 miles north of downtown Los Angeles. The magnitude has been calculated at 7.8 on the Richter Scale. An area of extreme damage extends from San Fernando north to the foothills and from Santa Suzanna Pass in the west to Sunland and La Crescenta in the east. Other areas of destruction include a strip six blocks wide, extending south from Van Norman dam to the Sepulveda Flood Control Basin; and downtown Los Angeles. Instances of major damage have occurred in Newhall, Fillmore, Piru and Castaic and in northern Los Angeles including Burbank, Glendale, Pasadena, Hollywood, Beverly Hills, Alhambra and Inglewood. The shock was felt from the Mexican border north to Parkfield, Fresno and Bishop and from the Pacific cast to the Arizona border and Las Vegas. The population was largely out of doors on its way to work. There was rush hour traffic on all major freeways. Offices and shops were staffed to about 20% of normal, and school children and non working mothers were at home.

CCMS No. 9

SCENARIO FOR THE NIIGATA EARTHQUAKE

From US Department of Commerce National Oceanic and Atmospheric Administration

On 14th May, 1971 an earthquake of Richter magnitude 7.5 occurred at 38°21'N, 139°11'E at 01:01 in the afternoon. The meizoseismic area included the northern half of the Niigata sedimentary basin, but the macroseismic area extended north and south for a total distance of 1,200 km from Hokkaido in the north to the vicinity of the eastern end of the Inland Sea in the south. The shock had its maximum destructive effects at Niigata about 40 km from the epicenter. A tsunami was generated. The population was just returning to work and to school; in rural areas, families were in the fields. The weather was clear; however, extremes of destruction occurred in alluvial areas where the water table was high and soil compaction was low.

THE SAN FERNANDO, CALIFORNIA EARTHQUAKE OF FEBRUARY 9, 1971

Prepared for The Office of Emergency Preparedness,
Executive Office of the President,
Washington, D.C.

by H.S. Lew, R.D. Dikkers,
E.V. Leyendecker, E.O. Pfrang,
S. Kramer

SYNOPSIS

Immediately following the San Fernando, California earthquake (February 9, 1971), a team from the Building Research Division of the National Bureau of Standards' Institute for Applied Technology, surveyed the damage to buildings and other structures. The areas investigated included the Newhall-Saugus area, the San Fernando Valley, and downtown Los Angeles. This interim report consists of photographs, most of which were taken by the team.

The full text may be obtained from:

Building Research Division,
Institute for Applied Technology,
National Bureau of Standards,
WASHINGTON, D.C. 20234,
U.S.A.

CMMS No. 9

SCHEMATIC TABLES ON THE ORGANIZATION OF CIVIL PROTECTION IN ITALY

(see/voir pages 4.1 to/à 4.4)

MANAGEMENT OF A RECOVERY PROGRAM
BY
JOSEPH H. FITZGERALD
(SUMMARY)

Effective management of a recovery program is both a policy and an administrative problem. Policy decisions are vital to the direction, scope, and public goals of the program. They provide the "Why" for what we do. Administration is equally important, for there is no more complex problem of coordination in government than the management of a disaster program. Federal, state, and local governments must be brought together in harmony and led down a common path. And the public must be brought in for some purposes and, in all cases, must be fully informed.

Within this framework, we can look at the recovery effort following the March 27, 1964 earthquake. It is a textbook case because the destruction was extensive, wide-spread geographically, and involved the economic heartland of the state. The efforts of government were also successful in meeting the challenge.

Policy

The policy goals established were based on a recognition that Alaska was a frontier area with a limited capital base, and that the economic aspects of the effort could be concentrated in a way that would lead to future economic growth and development. Broadly stated, the economic goals were:

1. Restore the economy as quickly as possible. The quicker the restoration, the lower the social cost to government. Ideally, the reconstruction effort should restore the tax base, so that taxes over a reasonable period equal the amount expended on reconstruction of the private sector.

   Also, by concentrating on growth areas of the economy, the restoration effort should stimulate future growth, so that the end result would be a better and faster growing economy than before the disaster. Under such circumstances the growth factor plus the restoration of the tax base should fully offset the cost of the recovery effort of government. Examples: OEP, SBA, and EDA programs at Anchorage and Kodiak.

2. Where facilities or industries are obsolete or mislocated, shift funds in a way to cause investment in adequate modern facilities and in the right location. In this way, industries and communities can be modernized and made more effective. Examples: Kodiak, Valdez, and Seldovia.

3. Recognition of the limits of economic policy. Restoration can only stimulate growth in an area that already has growth potential. This means that a sophisticated understanding of regional economics is required. Investment of state universities and other institutions would be helpful in this area.

Administration, management planning and programming tools as an aid in achieving cooperation and coordination, with a discussion of specific cases.

PLANNING FOR EARTHQUAKE-PRONE AREAS
BY
LIDIA L. SELKREGG

The Alaska experience points out that, in evaluating programs and procedures for planning in areas that are earthquake prone, three definite phases must be considered: prevention, immediate relief, and long-term recovery.

To develop and administer a prevention program, the state should have a planning agency responsible for comprehensive plans and policies. This agency should be specifically charged with developing statewide disaster-damage-prevention programs incorporating: (a) preparation of an overall state plan, which will evaluate potential disaster areas and their treatment in the event of disaster; (b) initiation of programs to prevent or minimize disasters, such as soil stabilization, harbor protection, and avalanche control; (c) adoption and enforcement of statewide building codes; (d) coordination of state and Federal agencies whose programs have an impact on disaster problems; (e) initiation of programs of public education; (f) provision for financial and technical assistance to local planning agencies in preparation and enforcement of disaster-prevention programs such as zoning ordinances, subdivision regulations, fire codes, building codes, and other regulations required for safe and proper development; (g) coordination of all local, state, and Federal activities related to development planning in potential disaster areas; (h) study and evaluation of all Federal programs applicable to disaster recovery and planning for the immediate participation of the agency as a coordinator of all planning activities in the event of a disaster.

The disaster relief program should incorporate public and private aid to relieve the immediate problems of public health, safety, and welfare and to allow the community to continue to function while broad decisions for disaster recovery are made. Local, state, and national governments should plan a coordinated program of disaster relief through an established agency such as the local office of civil defense. Under this program, provisions should be made for temporary housing and food, communications, health and safety, protection of property, reestablishment of basic community services, and financial aid to individuals for repairs to their homes and businesses.

The recovery program should recognize the broader, long-range implications of the disaster, including evaluation of regional and local economy, land use, transportation, and physical and social assets. Fundamental decisions on community goals, objectives, and policies; physical plans for long-range development; and construction and reconstruction plans should be develcped before the initiation of action programs by the various agencies.

The need for predisaster comprehensive regional development plans, including data on climatological, ecological, geological, and socioeconomic conditions of a region, was demonstrated by the difficulty in deciding the priorities of the reconstruction efforts and in establishing the relative value of fund grants to various communities.

The experience in Alaska has shown that, to expedite and successfully outline plans for action, a recovery task force composed of a wide range of technical and scientific personnel from all participating agencies should be assembled. This coordinating group of technicians should be thoroughly familiar with the adaptability and limitations of their various agencies' enabling legislation and administrative directives. It is only after careful evaluation of all programs with their potential and their application to each case that specific plans for recovery can be efficiently formulated.

Social Process During the Reconstruction Period

by

J. Eugene Haas

1. Significance of gaining perspective on the social characteristics of the community.

    A. Power structure considerations, public officials, powerful interest groups, opinion leaders.

    B. Ethnic and religious considerations.

    C. Beliefs regarding past and future disaster events.

2. Importance of trust between local "leaders" and "outside" planners and administrators.

3. Need for detailed knowledge of the community and its potential.

4. Significance of continuing data collection process.

    A. Necessary for planned changes and relevant response during rehabilitation process.

    B. Careful records and meaningful analysis necessary so that lessons can be learned and remembered for future policy formulation and enactment.

The Alaskan Earthquake: Economic Effects

by

George W. Rogers

Because of the nature of the Alaska basic economy (national defense, construction and selected natural resource harvesting) in 1964, there were no immediate or lasting detrimental effects such as would have been the case of a more developed economy with a significant manufacturing component. The impacts upon individual local area economies varied in nature according to the type of community (administrative centers, transportation gateway, natural resource harvesting and processing) and, in spite of their relatively small size and uniqueness, present important insights into the workings of economic reactions to unplanned major disruptions.

The economic effects of the reconstruction period, however, were of greater importance than the impact of the disaster. The state of Alaska was in a critical stage of its development both economically and politically. Earlier expectations of rapid economic growth which would have bolstered the development of political institutions were not being met on the schedule anticipated, and the state and local governments were experiencing financial difficulties when the disaster struck. The reconstruction activities not only pumped new outside money into the Alaska economy (which up until this point had been a construction dominated one), but provide a needed breathing spell and time of reappraisal and reordering of plans for future development.

Reconstruction and rehabilitation became merged with longer-run development objectives to the greater lasting benefit of the state and its people. This underlines the importance of periods of review and renewal in any developing society.

The Peru Earthquake of May 21, 1970: Ten Months of Recovery and Reconstruction

by

Stephen R. Tripp

1. Government of Peru estimate of damage--$500 million.

2. Outside Assistance.

   U. S. Government: $16.4 million grant; $23.3 million loan.

   Inter-American Development Bank: $35 million loan.

   International Bank for Reconstruction and Development: $30 million loan.

   United Nations' Development Program: $2 million planning grant ($1 million each from Cuba and Italy).

3. Government of Peru earmarked two to three percent of its budget for earthquake reconstruction. It plans to utilize approximately $100-200 million for reconstruction and development.

4. Assistance from Other Countries and International Organizations (e.g., the United Nations) in Support of In-Country Projects: included temporary housing and self-help shelter projects for approximately 50,000 family dwelling units; repair of a destroyed major electric power transmission line; furnishing of agricultural and urban development hand tools; providing agricultural credit for credit unions; replacing school structures and furnishings; building health centers and clinics; and repair of irrigation systems.

5. Assistance from Private International Voluntary Agencies: included self-help projects for repair of dwellings; generators for villages; assistance with agricultural projects, such as irrigation canals; rebuilding of entrance roads and small bridges; and help with reconstruction of classrooms, furnishings, etc. The total value of this assistance is approximately $10 million.

6. Interrelationships between country action and international action on rehabilitation and reconstruction.

CCMS No. 9

Restoration and Reconstruction

by

Mario Delle Chiaie

Criteria used for the removal of debris and for the demolition of unsafe buildings, on the occasion of the earthquake that occurred in January 1968 in Western Sicily, are briefly set forth.

Owing to such seismic phenomenon, the most serious among those recorded in Italy during the last decade, several built-up centers were destroyed or became uninhabitable.

Mention is made of the different types of buildings, that either collapsed or are likely to collapse (these buildings being mostly of tuff masonry and of two or three storys), of the machines (bulldozers, excavator tractors, and dumpers) used by squads of firemen as well as of modalities of actions and of the relative difficulties.

Some considerations resulting from the experience in this field are made on the performance of the different mechanical means employed and their best use.

CCMS No. 9

Reconstruction Criteria

by

Giuseppe Colucci

Some considerations on the more recently enacted Italian legislation in view of the reconstruction of areas affected by a earthquake.

Special character of laws in relation to the single disaster and need for some organic and complete legislation.

Recurrent principles and criteria of uniform actions even if there is diversity in laws.

Different types of actions and financing.

Bodies entrusted with these tasks.

Mention of the nature of the actions and of the antiseismic regulations.

PRELIMINARY REPORT - PERU EARTHQUAKE OF 31ST MAY, 1970

BY EARTH QUAKE ENGINEERING RESEARCH INSTITUTE
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INTRODUCTION

At 3:23:28 p.m. local time on Sunday, 31st May, 1970, an earthquake with a magnitude of approximately 7.7 on the Richter scale occurred with its epicenter located about 25 miles off shore at Chimbote, Peru, as shown in Fig. 1. The epicenter was located 9.4°S, 78.9°W and the focal depth has been reported to be 25 km. In terms of loss of life and property damage, this earthquake was the most destructive known to have occurred in the Southern hemisphere. The toll of human lives will undoubtedly never be known. Reports varied widely, at times by as much as a factor two or three. An approximation could be as follows: Yungay and Ranrahirca 20,000 dead, Huaraz 12,000 dead and all other areas 5,000 dead. Reports have placed the death toll as high as 70,000 dead. The number of collapsed adobe dwellings must surely have exceeded 100,000. Apparently the earth displacement was primarily lateral and not vertical because of the lack of any significant tsunamis associated with the earthquake. A difference in tidal elevation of 3.7 feet was recorded over a period of approximately 45 minutes in Chimbote.

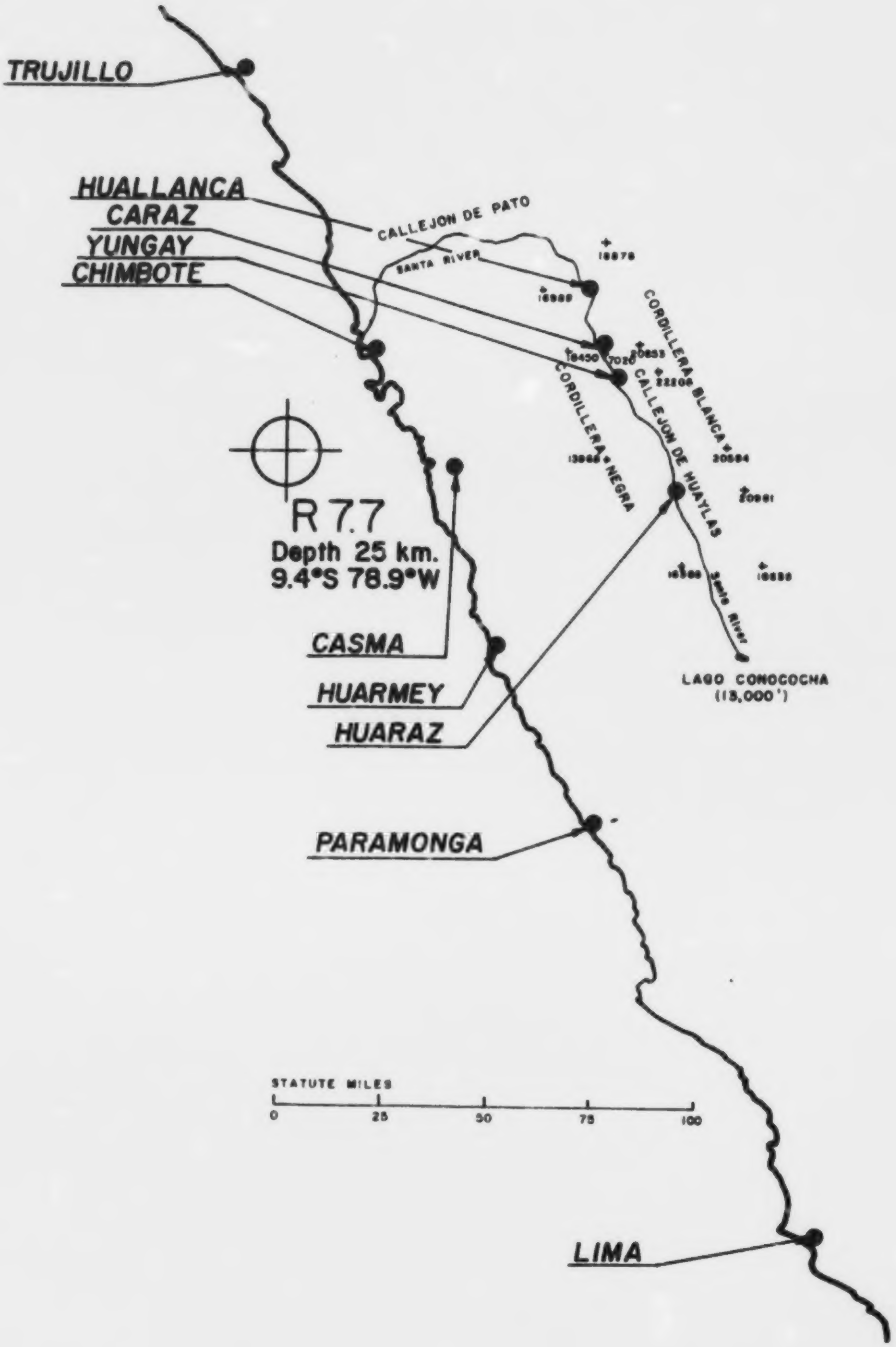
The earthquake had a devastating effect on the coastal cities and towns of Chimbote, Casma, and Huarmey. Trujillo suffered damage to a lesser degree, and at Paramonga slight damage was noticed at the Complejo Industrial (W.R. Grace Plant) and its adjoining housing areas.

The devastation in the above areas was due almost entirely to the collapse of adobe dwellings. Other failures occurred in reinforced concrete schools and commercial buildings. A two-story reinforced concrete convent (with brick filler walls) completely collapsed in Chimbote.

Collapsed dwellings were found from Trujillo to Agro Pecuaria Santa Rosa just south of Paramonga, a distance of approximately 220 miles.

Perhaps it should be noted that some very minor damage was recorded in Lima and Chiclayo. The two cities are approximately 450 miles apart.

The three-span bridge at Casma (35 miles from epicenter) was thrown completely off its rollers, while an identical bridge between Trujillo and Chimbote at Viru (65 miles from epicenter) was undamaged. Ground motion was very evident at the Casma Bridge.


TRUJILLO
HUALLANCA
CARAZ
YUNGAY
CHIMBOTE
CALLEJON DE PATO
SANTA RIVER
CORDILLERA BLANCA
CORDILLERA NEGRA
CALLEJON DE HUAYLAS
18450
7020
20853
22206
20584
Santa River
LAGO CONOCOCHA
(13,000')
R 7.7
Depth 25 km.
9.4°S 78.9°W
CASMA
HUARMEY
HUARAZ
PARAMONGA
STATUTE MILES
0
25
50
75
100
LIMA

Showing Location of Epicenter

The Centro de Salud (hospital) at Huarmey was only slightly damaged, while the identical design at Casma was near total collapse.

The Callejon de Huaylas is a beautiful valley situated between two ranges of the Andes known as the Cordillera Negra and Cordillera Blanca through which the Santa River flows. The Cordillera Blanca on the East side has peaks that range between 20,000 and 22,000 feet. The Cordillera Negra is about 5000 feet lower. The valley slopes downward to the North, Huaraz being at about 8700 feet and Caraz at about 7500 feet in elevation. The distance between Recuay at the South and Huallanca at the North is approximately 85 miles. Most of the communities of this valley were founded on an alluvial terrace formed by the Santa River.

SOILS AND GEOLOGIC EFFECTS

Introduction

The area affected by the earthquake includes the low-lying coastal zone and the highest mountains in Peru. In some areas the foothills of the mountains reach to the coastline. The mountains reach an altitude of approximately 15,000 feet within 50 miles of the coastline and an altitude of up to approximately 22,000 feet approximately 65 miles from the coastline. The entire area between the coast and the mountains is barren with essentially no vegetation except in the river valleys leading from the mountains to the coast. It is in these river valleys that practically all of the villages and towns are located because of the lack of water away from the river valleys. In the coastal zone there are many sand dunes and areas covered with windblown sand which reach up into the rock foothills along the coast. Except for the sand cover on some parts of the foothills, the surface consists of fractured rock without any soil cover.

Many of the rivers carry a large load of solids from the mountains and as a result the river valleys contain a large amount of alluvial material at the lower elevations. Generally, the water table is high in these alluvial areas. This is particularly true in the areas of Casma and Chimbote.

In the mountains in Callejon de Huaylas, which runs approximately north and south, there are numerous side valleys and canyons reaching into the high mountains on each side of the valley. Streams and rivers flowing from these feed into the Santa River which runs north in Callejon de Huaylas. At the north end of the valley the Santa River enters Canyon del Pato and swings westerly, reaching the ocean just north of Chimbote.

The towns in Callejon de Huaylas are located along the Santa River and are generally built on an alluvial terrace. Some of the deposits have been carried down the side valleys. from the mountains to the east as mud and debris flow, depositing large amounts of materials suddenly and causing severe damage or total destruction to any towns or villages in their path.

Canyon del Pato is a very steep-sided gorge and is nearly inaccessible. A railroad has been built through it from Chimbote to the north end of Callejon de Huaylas but an automobile road had not been constructed through it.

It is not the intent to describe the geology of the area herein in detail. Information on the kinds of rock and their history are available elsewhere and more detailed geologic reports pertaining to this earthquake will be prepared by others.

Soil Conditions

The soils in the lower river valleys and along the coast generally appeared to be silty fine sands. At the paper plant at Parmonga it was reported that such soils extended to a depth of about 10 feet, at which depth gravelly deposits were encountered. At Chimbote, information from some soil borings on land indicated that the silty sand was very loose for a depth of about 3 feet and was only slightly denser to a depth of 15 feet, the depth of the borings. Borings drilled in connection with the design of the ore handling wharf at Chimbote indicated that on the order of 3 to 15 feet of black mud was present on the bay bottom. This was underlain by loose silty sand extending 5 to 15 feet deeper. A very dense sand deposit was encountered below the silty sand.

The area on which most of Chimbote is built is low-lying. It appears that the surface soils are probably windblown fine sands which may overlie alluvial sands over a large part of the city. In the southern part of the city marshy areas are still present in areas which have not been built upon. Reeds and other water-oriented plants grow profusely in the marsh areas. It is probable that windblown sands covered such marshy areas in some parts of Chimbote before it was built up.

In the area of the new addition to the steel plant at Chimbote, the ground surface is somewhat higher than in the downtown area of Chimbote. The soils exposed in a cut slope in the yard area indicated that the soils are basically a silty fine sand which contains many rock fragments apparently derived from talus material from the nearby hills. Interspersed in this were sand lenses which apparently were of windblown origin.

Geologic Effects

The most spectacular result of the earthquake was the debris avalanche which originated on Mt. Huascaran and destroyed Yungay and Ranrahirca. In addition, the shaking caused slides and dislodged rocks on both natural and cut slopes. The roads leading into Callejon de Huaylas were temporarily closed because of slides. In Canyon del Pato the railroad line was destroyed in part by rock slides from the steep canyon walls.

At Chimbote the area adjacent to the marsh and probably the marsh area itself settled as a result of the shaking. No elevation measurements were available at the time of inspection of this area, but the water which covered previously dry areas indicated that some subsidence must have occurred. It appeared that the water which inundated the low-lying area resulted from water which was expelled because of densification of the soil due to the shaking.

Along the shoreline at Chimbote, movement of the soils towards the ocean occurred. The amount readily visible was on the order of 4 to 6 inches, varying somewhat along the length of the waterfront. While the movement appeared to be basically horizontal, some vertical movement occurred as is evidenced by the settlement of the patio area at the Chimu Hotel with respect to the hotel itself. This amounted to approximately 1-1/2 inches at the hotel. Similar movements were reported to have occurred in other coastal areas near the epicenter.

Just north of Chimbote a fishmeal plant built at the base of a rock hill was practically destroyed by a rock slide from the hill. Farther north, on the delta of the Santa River, movements occurred on the side slopes of a creek or irrigation channel.

Where the Pan American Highway traverses the marsh area in Chimbote, considerable movements of the roadway fill occurred. Reportedly, the fill split down the middle, leaving an opening of approximately 3 feet width. With this type of movement and the failure of the slope at the edge of the roadway, the raod was not usable until repairs could be made. Near Casma, where the road passes over the alluvial river deposits, there were indications of subsidence of the fill because of the bumps in the roadway at culvert and small bridge structures. Reportedly, water spouted to a height of about 3 feet in cracks in the paving at some points and water flowed along the side of the road as a stream for several hours after the shaking had stopped. The road had suffered some damage in this area but was not completely unusable. Where the road runs along the base of a rock hill, rocks fell from the hill and blocked the road. At the Casma River bridge subsidence of the approach fills at each end of the bridge occurred and the abutments moved towards the river. The ground surface upstream of the bridge approximately 50 feet from the river was cracked and it appeared that sand had been carried up from below the surface soils by water from this crack.

At the water supply facilities for Lima, at Atarjea on the Rimac River east of Lima, loose soil which had been placed on the outside slope of a reservoir embankment showed signs of creeping down the slope. The total amount of movement was on the order of 2 to 3 inches.

TYPES OF CONSTRUCTION

By far the most common form of construction is adobe, which is used for most of the houses and small structures throughout the region. Many two-story and a few three-story adobe buildings exist, some of them quite large. Some roofs are mud plastered over cane on timber joists, some are tile-formed concrete joists and slabs, and some are tile or corrugated transite on wood pole rafters. Bearing wall brick buildings are frequently used for shops, apartments and residences. Some have bond beams and some do not. Reinforced concrete framed structures with brick filler walls are used for many smaller industrial structures, shops office buildings, apartments and schools. The four or five major industrial buildings in the earthquake region are traditional braced steel-framed buildings with steel trusses and purlins and corrugated iron or asbestos cement (transite) roofs.

Quincha construction is frequently employed for residences in the coastal region. A quincha wall consists of vertical poles spaced a meter or two apart, usually braced at the bottom in the plane of the wall, with a horizontal cap pole tied to the vertical poles at the top. Two or three equally spaced horizontal poles or canes are tied to the verticals to complete the basic frame work. Then canes are placed vertically, tightly spaced and woven between the horizontals in a basket weave. Finally the wall is plastered with mud on both sides. The roof is usally built of wood pole joists or rafters thatched with grass or covered with corrugated iron.

Quincha construction is quite flexible compared to adobe construction and thus has the highly desirable property of flexing with the ground motion; that is, it will "roll with the punch." whereas adobe is brittle and will not tolerate much motion without cracking and falling.

In general, a few comments on the materials used for construction would be noteworthy.

(a) The mortar used in adobe construction seemed to be almost a cohesionless material in its final form.

(b) The quality of the adobe blocks appeared to be better in the inland areas as contrasted to the coastal regions.

(c) Concrete in many instances appeared to be of poor quality. This may have been the result of unclean aggregate, low cement content, and improper aggregate grading. Visual observation indicated that perhaps 750 p.s.i. to 1500 p.s.i. was the usual compressive strengths obtained, with perhaps 2000 p.s.i. in some of the schools.

(d) The slow rate of construction combined with the salt atmosphere of the coastal regions permitted, the long time exposure of the reinforcing to accumulate considerable rust scale before pouring of concrete. This scale, in most places noted, had not been removed and bond was indeed questionable.

EARTHQUAKE INTENSITY

The Modified Mercalli scale of earthquake intensity is inexact and somewhat subjective, and an observer may get different results by selecting the effects he wishes to observe. Attempting to appraise the intensity on the basis of average effects in the locations named, and taking into account the quality of construction, we find the Modified Mercalli Intensities to be:

CASMA	VIII
CHIMBOTE	VIII
HUARAZ	VII-VIII
HUARMEY	VII
TRUJILLO	VI-VII
HUALLANCA	VI

STRUCTURAL DAMAGE AT VARIOUS LOCATIONS

COASTAL REGION

Along the coastal region of Peru, significant structural damage was found from Agro Pecuaria Santa Rosa to Trujillo, a distance of some 220 miles. Casma, about 35 miles from the epicenter, and Chimbote, about 25 miles from the epicenter and located near the middle of this coastal strip, were the most severely damaged coastal cities. The following are comments concerning selected buildings in towns along the coastal region of Peru.

Agro Pecuaria Santa Rosa:

This very small village (perhaps 30-40 dwellings) is located about 140 miles from the epicenter of the earthquake.

Although rather far removed from the epicenter, every dwelling in this village collapsed. One eyewitness told of the earth opening up and closing repeatedly with a seemingly much exaggerated description.

All dwellings were constructed of adobe bearing walls.

Paramonga:

Located about 100 miles from the epicenter, is the site of the Complejo Industrial Paramonga (W. R. Grace Plant) consisting of a sugar refinery, paper mill and chemical plant. Cane fiber from the sugar operation is used to make paper. The administration building, a two-story reinforced concrete frame building with brick filler walls, had been damaged by the previous 7.2 Richter Magnitude earthquake of October 17, 1966, located about 75 miles due west of Paramonga. The building has 16 bays - nine at one end and seven at the other, separated by an expansion joint. The end wall in the first story of the 9-bay segment failed, and column damage occurred at the second floor beams at four locations. Transverse brick walls in the first story were cracked at several locations. Damage was much less severe in the 7-bay portion of the building than in the 9-bay portion because the 7-bay portion has transverse shear walls in every bent, and the 9-bay portion has no transverse shear walls except at the end. The building could have collapsed had a little stronger or longer earthquake occurred. The end wall reinforced concrete beam and column frame showed a typical type column failure observed at several locations throughout the devestated area.

The paper mill is a large steel-framed mill building, with a corrugated transite roof supported on steel purlins and trusses and columns. Most of the exterior walls are infilled with clay brick. Damage was not severe. A few exterior wall panels high in the building fell out and an elevated tank inside the mill was thrown off its supporting platform. No settlement of foundations had been found. The paper machinery had been thrown out of alignment, and four days of production were lost while adjustments were made.

Huarmey

In this small town which is about 60 miles from the epicenter, most of the buildings were adobe and almost all of them were damaged or destroyed. In stark contrast with the adobe structures were the quincha dwellings. Some of them were damaged but they remained intact except for a few dislodged roofs or some spalled wall coatings.

The church at the plaza was totally demolished. Only the damaged reinforced concrete tower remained standing.

Of some interest is the Mercado Modelo, a market with sixteen concrete columns supporting the roof structure. Although torsion was introduced into the structure (by one side having no filler walls) it would seem by observation that this structure should have withstood the quake with considerably less damage. The structure was measured and framing plan, elevations and stress calculations have been made.

Nearby stood two old buses, without wheels, each of which had been placed on four concrete block piers about three feet off the ground. Observation would indicate that not too high a lateral acceleration was experienced in this town or the buses would have been knocked off of their supports.

The Centro de Salud (Hospital) in Huarmey was only slightly damaged. It was of identical design and construction as the one in Casma, which suffered very extensive damage.

Some slight ground motion was observed to have taken place as indicated by ground cracks.

Casma

Casma, about 35 miles from the epicenter, was almost completely destroyed. Nearly all of the buildings were adobe, and virtually all of them were either reduced to rubble or damaged far beyond repair. The bank building, a reinforced concrete frame building with brick infilled walls, had its parapet wall nearly dislodged but was otherwise intact.

The recently constructed Centro de Salud (Hospital) not yet occupied, was severely damaged.

This one-story building was constructed with reinforced concrete frames, infilled unreinforced and unanchored concrete block interior partitions and exterior walls, and typical roof reinforced concrete joist construction formed by spaced clay tile. Severe damage occurred to all masonry construction. Also critical damage occurred to many column-beam connections throughout the building. Anchored equipment was not damaged; some unanchored equipment was damaged. Glass breakage was generally found throughout the entire building. The concrete elevated water tank at the hospital site appeared to be undamaged.

Essentially all of the buildings of a large Casma School collapsed or were seriously damaged. Construction was primarily of reinforced concrete frame with masonry infilled walls. One building had roof trusses of light steel construction which had collapsed. Another had wood roof joists but had not collapsed. Most of the buildings were probably less than 10 years old.

One wing which appeared to be essentially completed, as it had not yet been painted, had the typical short column damage found throughout the stricken areas. One of the roof overhang beams of reinforced concrete sagged considerably when the brick wall crumbled opposite the bottom or the compression side of the beam.

A water tank on this school site collapsed. This was the only water tank failure observed throughout the earthquake stricken area.

A three span steel truss bridge crosses the Casma River about 2 - 3 miles south of the city of Casma. Each truss, a simple span, rests on hinged supports at one end and on segmental rollers at the other. The abutments were displaced toward midstream during the earthquake.

The concrete piers also were displaced slightly. The relative displacements between the trusses and their supports were great enough to rotate all the segmental rollers beyond their critical angle of rotation, and the rollers had fallen flat between the upper and lower bearing plates.

By contrast a seemingly identical bridge between Chimbote and Trujillo, at Viru, suffered no damage.

Chimbote

Chimbote, about 30 miles from the epicenter, is a city much larger than Casma or Huarmey because of the large fishing industry and the steel mill. Construction comparable to that found in Casma or Huarmey suffered damage of equal severity here. There was, however, larger and better commercial construction found in the downtown area.

Many of the adobe buildings were reduced to rubble and few escaped severe damage. Some districts, notably the San Pedro district, were damaged to a greater extent that Casma.

Perhaps the most earthquake engineering informative structures in Chimbote were its schools.

The Marianista "Normal" School is a two-story three year old reinforced concrete frame building with infilled, unreinforced concrete block masonry. It suffered considerable damage to the frames and masonry walls but did not collapse. The second floor and roof slab were composed of infilled clay tile concrete joist construction. Such clay tile about 20" in length were set about 4" apart thus arranged to form concrete joists 4" wide spaced 24" and supporting a 2" slab when concrete was placed between and over the tile. Extensive damage occurred to the concrete block longitudinal and cross walls which were unreinforced and unanchored. Also, the concrete columns, all of which were about 11" wide and 23" deep, were extensively damaged at the top where they frame into the beams. Damage was greater within the first story than within the second story; however, serious damage occurred within both. Many masonry walls fell out of the frames. Such wall collapses would surely have caused deaths or serious injury to many students had the earthquake occurred during school hours.

An interesting observation can be made which typically shows greater damage to the top of the columns where the cross walls are located and less damage where no cross walls existed. A possible explanation for this behavior is primarily twofold. First, the infilled frame being stiffer than the frame without a wall initially resisted a larger load. Secondly, due to the unanchored infilled section a single concrete column of the frame had to carry all of the shear in this bent, rather than each column carrying an equal amount. It is presumed that at the time of failure of the infilled section, an impact load is applied onto the concrete frame due to the sudden fracture. Further, after the diagonal tension failure of this infilled wall one of the concrete columns must obscrb most of the load, therefore it is the opinion of this Committee that the resistance of concrete frames may be impaired by the addition of these infilled masonry walls; a phenomenon which was found in some failures that occurred throughout the entire devastated area.

Brick veneer on the end wall was dislodged generally throughout the wall. Apparently nominal anchorage was provided at the floor line.

Brother Daniel Calvo, who occupied an apartment on the second floor of this school and escaped without injury, reported seeing ground waves in the nearby school yards "going in all directions which were about 12 feet between crests and about 1 foot in height."

The San Pedro Consolidated School is an 8 or 10 year old school consisting of several wings one of which was oriented 90° to the main wings. Damage was similar in all wings and not particularly related to orientation. In all wings the short stiff columns suffered serious damage and the longer more flexible columns suffered little damage. There was, however, an exception to this. This may be explained by evidence of settlement at the end of this wing which may have increased the vertical load on the column.

The Polytechnic School is a 12 or 14 year old one-story school with saw-tooth roof shop buildings constructed of burned clay brick walls, concrete columns and bond beams, parallel chord wood roof trusses, wood purlins and subpurlins, and roof of corrugated asbestos cement. That portion of the brick wall above the bottom chord of the truss closing in the saw-tooth ends of the building was dislodged and fell. This masonry was unreinforced and no anchors were placed in the top of these unreinforced brick walls to connect the corrugated asbestos cement to the walls for their lateral support. No roof diaphragm was provided.

No damage was apparent to the remaining masonry walls nor to the wood trusses; however, several panels of the corrugated asbestos cement were destroyed, probably as this material attempted to act as a roof diaphragm.

The Regional College was dedicated in April, 1970, and was not yet completely operational. Here again the short reinforced concrete columns were seriously damaged and the longer columns on the opposite side of the buildings were not damaged except at one location where a rock pocket existed in the column.

Upon a cursory review of the plans at the site it was obvious that the rigid frames in the sawtooth roofed shop buildings and the rigid frame in the auditorium were designed for some lateral forces. The frames of both these buildings had little damage. There was, however, damage to the masonry walls in the auditorium but to a much lesser extent in the shop walls. Several light fixtures in the shop buildings fell to the floor. They were anchored with a single bolt about 1/4" diameter located at the center of the fixture.

The Colegio Mundo Mejor is a two-story reinforced concrete frame, concrete block infilled wall school, approximately two years old. It was located in a neighborhood where there was considerable settlement of buildings and soils. Homes nearby were in one to two feet of water; see Fig. 28. Local residents reported that prior to the earthquake the water table was 1½' to 2' below the surface of the ground. They also reported that the surface of the level of the ground appeared to have settled.

This school had no significant damage to the frame or to the walls. There was, however, some slight spalling damage at the expansion joints located in each wing.

The ground floor of each classroom was bulged up in the center about 16". Apparently, the whole building settled uniformly thereby merely bulging the ground floor slabs upward.

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The Convent of the Dominican Mothers of Columbus, Ohio, was a two-story reinforced concrete building about three years old with unanchored, unreinforced concrete block walls. The building was a total collapse.

The unreinforced concrete block school for the handicapped, operated by these nuns adjacent to this convent, was seriously damaged to a point where it may be demolished.

The hospital Obrero is a complex of brick bearing wall buildings. The exterior walls were cracked throughout and much glass damage occurred. This hospital continued to remain in operation.

The Banco Nor Peru is a four-story reinforced concrete building. At the rear of the building is a mezzanine floor which gives lateral support to the rear columns at mid-height. Failure occurred at the stiffest elements, namely, the rear wall and the rear columns that were braced at mid-height by the mezzanine floor.

The Sogesa Steel Mill is the largest installation in Chimbote. It consists of a large two crane ore unloading structure and conveyor system, a furnace building, a rod and angle mill, a new light gage plate mill, an oxygen building, and other auxiliary buildings and administration building.

At the new Steel Light Gage Plate Mill, a plant that was to be opened a few weeks after the quake, the floor slab (a slab on ground) suffered settlement. A close inspection showed that these settlements occurred near and adjacent to deep pits built in the floor. These pits were 25 to 30 feet deep. These settlements were attributable to the consolidation, during the quake, a backfill placed around these pits. In one area two large steel rolls weighing between 60,000 and 75,000 pounds caused the slab to settle more than the usual settlement. This particular area settled about 4 inches. The north end of the pickling line had settled about 12 inches. Realignment of cranes and machinery will doubtless be a time consuming task. A considerable amount of the corrugated asbestos cement roofing and siding broke at the hook-bolt connections and fell to the ground.

A reinforced concrete storage building located at the Steel Mill site had several fractured columns, the most severe fractures occurring in the clerestory portion.

The ore-handling dock of the Corporacion del Santa, serving the steel mill, shifted laterally. Hydraulic fill adjacent to the east side of the dock, settled on the order of six feet and the outer half of the pier shifted laterally about three feet. A horizontal separation of 21 inches occurred between the wharf structure and an electric substation at the outer end of the wharf. Several concrete pilings in the two bents closest to shore were cracked just below the pile cap.

Essentially all of the approximately 10 fish plant finger piers suffered damage due to settlement and lateral movement. These piers were not loaded at the time of the earthquake. One pier under construction suffered damage similar to the other piers and the outer 180 feet completely collapsed.

A new pier for handling fish boats at a repair yard did not suffer noticeable vertical movement but moved longitudinally approximately 6 inches.

Hotel Chimu, a three-story structure located on the water front, was undamaged. Cracks in the ground running parallel to the shore line were evident in the street end in front of the hotel building.

Trujillo

Trujillo, about 85 miles from the epicenter, suffered far less damage than other coastal towns in the stricken area, but many adobe buildings collapsed partially or completely and some brick and reinforced concrete buildings with infilled walls were slightly damaged. The quality of construction in Trujillo was without doubt better than in other towns described in this report, and had a much older and much more established appearance to it.

A reinforced concrete elevated water tank just being completed in the south part of the city was undamaged.

An adobe sign, also at the south end of Trujillo, suffered no damage; it was 16" thick, 13'-6" wide and about 20' high above the first step of the footing. It is amazing such a structure remained standing, whereas many adobe buildings nearby collapsed.

At the Clarianca Seminario Religioso (a Catholic School) four identical classroom dormitory units had been constructed. Only the Southwest unit suffered minor damage.

At the College St. Vincent de Paul, a typical two-story school building dedicated in 1960, little damage occurred to any of the school buildings. In the new large auditorium a few acoustical ceiling tile under the balcony were loosened but did not fall.

Many other buildings in Trujillo of reinforced concrete framing with infilled masonry walls resisted the quake with little or no damage including some buildings that had little evident strength to resist lateral forces.

The parapets and part of the top story of the Municipalidad (City Hall), a brick building adjacent to the Plaza de Armas, fell to the street.

The cupola of the main dome in the 350 year old cathedral fell through the dome onto the altar structure below, thus causing it to collapse. One of the sub steeples became dislodged and fell through the main roof to the floor below.

A large hospital suffered only slight damage in the main structure due to pounding of adjacent sections at a construction joint and re-entrant corner. More damage occurred at the nursing school, which had been built on a fill that settled during the earthquake. Unreinforced clay brick walls were cracked and one foot high glass windows in the demonstration-lecture room were broken.

Salaverry

Salaverry, about 75 miles from the epicenter, had negligible damage. Many buildings in the town are wood frame buildings with wood siding. Neither the sugar warehouse nor the adjacent loading dock equipment at the marine terminal appeared to have suffered any structural damage. Concrete slabs on the fill at the shore end of the loading dock settled a few inches.

MOUNTAIN REGION

The Callejon de Huaylas, frequently referred to as the Callejon, is the beautiful valley formed by the Santa River as it flows north from Lake Conococha for a distance of about 100 miles, thence into the Canyon del Pato, a very steep walled canyon about 65 miles in length, and then out to the Pacific Ocean.

The towns and villages in the Callejon have many adobe buildings of one or two stories with a few three-story dwellings. The adobe generally appeared to be of better quality than that of the coastal cities. Throughout the Callejon more than half of the adobe buildings collapsed, or were seriously damaged. Most of the brick and reinforced concrete frame buildings with brick filler walls survived, many of them with little structural damage. All buildings within the debris flow were completely wiped out. The following towns are located in the Callejon de Huaylas.

Huaraz

Huarez, about 95 miles from the epicenter, was the location of severe destruction from vibrational effect. Almost every adobe building in the south portion of the town was completely destroyed. Most of the buildings in the north portion, consisting of one and two-story brick or adobe construction, were rebuilt after an avalanche in 1941 resulting from the collapse of a natural dam of a lake above Huaraz. The buildings in this rebuilt area of Huaraz in general, suffered little damage.

The situation in Huaraz was perhaps the worst in Peru. Because most of the adobe dwellings were two and a few three-storeys in height and the streets were so narrow (maybe 15 feet or so) people who had run out into the streets were crushed by buildings falling on top of them.

One nun explained as she was pointing to her school, that four nuns and perhaps 300 children lay under the rubble that once was their school. Also that probably 400 or so people were buried in the collapse of the theater. Certainly hundreds of other people lay beneath the rubble of the many demolished buildings.

The steeples of the cathedral opposite the Plaza de Armas, collapsed. Yet in the midst of this devastation there were buildings of reinforced concrete frames with brick filler walls and brick buildings that survived very well. Apparently the earthquake vibrations were less severe in Huaraz than in the coastal towns of Huarmey, Casma and Chimbote because comparable construction which had some lateral force resistance suffered less in Huaraz.

The city hall, opposite the Plaza de Armas, a two-story reinforced concrete frame building with brick walls and tile roof, showed strong evidence of motion but did not appear to be seriously damaged.

The library building of the Corporacion del Santa adjacent to the city hall was dedicated in May 1968. It is a one-story building constructed with reinforced concrete rigid frames and brick walls. Damage to this building was limited to dislodged roof tiles and nominal cracks in the brick walls. There was essentially no structural damage.

One three-story building with brick filler walls next to the Plazs de Armas remained standing, but was severely damaged. That building, as well as several others in Huaraz, employed brick as the principal structural material with reinforced concrete columns and bond beams.

The hospital, built in 1963, is a complex of one and two story wings. It suffered some nominal structural damage to the brick infilled walls and reinforced concrete frames. The roof tile on all of the wings was dislodged.

In each instance the tile slipped or was bounced down the roof slope to such an extent that there was no tile within about three feet of each roof ridge. It was reported that many injuries resulted from the roof tile falling on the occupants as they attempted to escape from the buildings. In Huaraz there was a large amount of dislodged roof tile.

At the hospital a reinforced concrete water tank supported on four columns braced by intermediate horizontal beams did not collapse; however, there was some nominal cracking at the intersection of the beams and columns and at the column bases.

The hospital power house was built with corrugated iron roofing supported by steel purlins on steel trusses and reinforced concrete columns. Walls were of adobe. The roof was braced with steel rods about ½" in diameter. Several rods were broken and many were deformed so that they sagged. Damage in this building was very nominal and limited to the rod bracing and cracks in the walls.

A two-story school building was under construction at the time of the earthquake. Little damage occurred to the building. This school had a roof of corrugated iron supported by wood trusses. The walls were of plastered infilled masonry and frame of reinforced concrete. The second floor was constructed of reinforced concrete slab formed by spaced clay tile so commonly found throughout the earthquake area.

A five-story reinforced concrete frame building with infilled walls was nearing completion at the market area. Some of its brick filler walls were cracked. The three-story school, probably was constructed after the 1941 mud flow which covered this portion of Huaraz. This school building had frames of reinforced concrete, infilled walls of unreinforced brick masonry, wood roof trusses, and a roof of corrugated transite. Half of one wing collapsed and the adjoining portion of the same wing was on the verge of collapsing. An expansion joint separated the collapsed and the standing portions of the wing. The concrete frames at the expansion joint apparently could not resist the induced torsional forces.

Yungay and Ranrahirca

Yungay and the neighboring town of Ranrahirca were wiped out by the debris avalanche from Mount Huascaran. This earthquake will be recorded in history, not only for the damage to man made structures and the related loss of life, but also for the huge debris avalanche originating on Mount Huascaran which probably took 20,000 lives.

Mr. Mateo Casaverde, a geophysicist at the Geophysics Institute of Peru, was an eyewitness to the event and gave the following account. He stopped in Yungay near the cemetery about 3:00 p.m. Sunday, May 31, the afternoon of the earthquake, to photograph Mount Huascaran. Through his telephoto camera lens he observed a series of rather deep horizontal cracks in the glacier on the face of the mountain and commented to his companions about the possible danger associated with those cracks. They returned to their car and proceeded in a southerly direction a short distance to the end of the curve in the road opposite the cemetery, when the earthquake occurred.

The vibrations were so violent that he stopped the car. He saw several adobe homes fall and the small bridge ahead of them collapse. Knowing of the imminent danger and of the past history of avalanches or debris flows in Ranrahirca in 1962 and in Huaraz in 1941, they ran for the cemetery hill about 150 to 200 yards away. At this time there was a strong blast of wind accompanied by a continuous deafening rumble. Upon arrival at the base of the cemetery hill, Mr Casaverde turned to look back toward Mount Huascaran and saw a huge wave of debris above Yungay. He ran up to the third tier of the cemetery just as the mud flow reached this highest level. Two women about 12 feet behind him did not reach the safety of this level and were swept away to their death.

Much discussion centered around the velocity of the flow. Consensus of opinion placed the velocity at approximately 200 miles per hour.

The speed and time of travel for this avalanche also coordinates closely with the avalanche which covered Ranrahirca on January 10, 1962. A very good report of that avalanche is given in the June 1962 issue of the National Geographic magazine.

The debris flow originated from a large block of ice and rock about one half mile wide and about a mile long at an average elevation of about 18,000 feet on the side of the north peak of Mount Huascaran, approximately 9 miles from Yungay. This peak's elevation is given as 21,860 feet, whereas the south peak at Mount Huascaran is at 22,205 feet.

The debris avalanche came down the Llanganuco River Valley from Mount Huascaran, buried Ranrahirca killing its 3,000 to 4,000 residents, then plunged down the Santa River apparently in a single long large wave all the way to the ocean. A small lobe of the debris topped a ridge and flowed over Yungay killing an estimated 17,000 people. As the debris flow hit the west, or opposite, bank of the Santa River at Ranrahirca, the avalanche washed up the opposite bank about 400 feet or more. The depth of the flow at Huallanca was 200 feet and about 8 or 10 feet where the Chimbote - Trujillo road crosses the Santa River. Judging from the height of an uprooted palm tree at the Plaza de Armas in Yungay and comparing the height above grade of the palms remaining in the Plaza, the depth of the debris is estimated to be 11 feet.

A rough estimate of the amount of material in the whole debris avalanche is about 75 million cubic yards.

The material in the flow ranged from large boulders estimated to weigh about 700 tons to fine silts. Craters formed by chunks of ice were found in the mud at Huallanca, 35 miles below Yungay; this was evidenced by a crater up to a foot across with clean rocks in the bottom of the crater.

The debris flow took out the dam and a bridge to the power house at Huallanca. No evidence of either was found.

CONCLUSIONS AND OBSERVATIONS

1. The earthquake was not a good test of modern construction as used in the United States of America because too few buildings designed in accordance with contempoary U.S. standards were within the area of its effect.

2. It is probable that had structures designed and constructed according to lateral force requirements of California been subjected to this earthquake, minor damage could have occurred, but the structures would not have collapsed.

3. This earthquake again demonstrated that in addition to building failures, utilities, bridges, and highways will also suffer considerable damage.

4. Most of the collapses occurred in areas where structures had been constructed on alluvial deposits.

5. It is possible the high degree of reported vertical vibrations increased the amount of consolidation of loose soils in Chimbote. This condition would apply to both alluvial and man-made fills.

6. Where concrete columns are the means of lateral resistance, concrete outside of the column cage should be ignored in both shear and bending.

7. Brick bearing walls and brick filler walls generally fared better than adobe bearing walls and adobe filler walls. All were unreinforced.

8. Since many concrete columns failed at the beam soffits, some additional research work appears to be necessary utilizing simulated earthquake loadings rather than mere stress reversals.

9. Exterior concrete columns tended to "walk out" from under concrete beams, where beam-column failures occurred.

10. Column ties were generally widely spaced and had 90° bends at the corners. The "opening" of these ties was very evident in some columns. Had 135° bends been used this "opening" might not have occurred.

11. Concrete generally appeared to be of low quality, with large aggregates in small columns, unwashed aggregates, low strengths (probably 750 p.s.i. to 2000 p.s.i) and over-sanded mixes.

12. Torsional resistance and relative stiffness of all members in the whole building must be given consideration. This includes the stiffness of each column in each direction and the stiffness of all walls. This was apparently overlooked in the few engineered structures that failed.

13. The structural integrity of all infilled walls must provide for all loads normal and parallel to the plane of the walls.

14. Unreinforced and unanchored masonry should not be used in areas of seismic activity.

15. The installation of glass must be consistent with the stiffness of the structural frame of the building or the support of the glass. The stiffness of the frame should be sufficient to prevent glass breakage or details of sash and glass installation must be provided which will allow the frame to move without imposing load on the glass.

16. The nature of the soils and their behavior under static and seismic conditions must be considered in the design of a structure.

17. All elements of a building such as partitions, fixtures, veneer, sash, railings, roof tile, etc. must be designed for the lateral forces to which they are subjected.

18. Beam bars and column bars, throughout their joint intersections, must be held in place by means of column ties and closed beam stirrups.

19. For a uniform level of safety of construction, proper building regulations must be adopted and enforced. Continuous construction inspection by competent personnel is required for compliance with the design concepts and drawings.

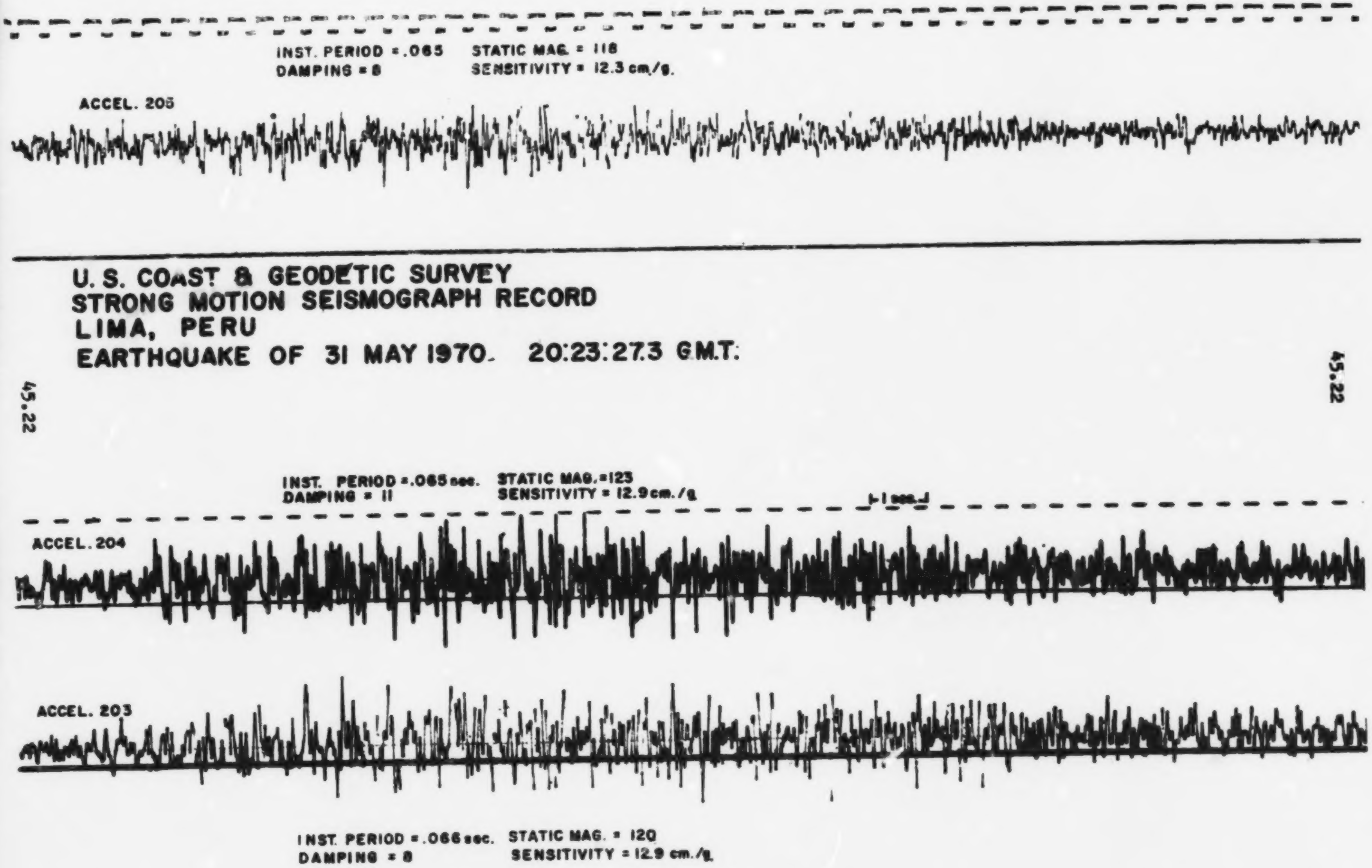
20. Where a concrete frame is designed to resist lateral forces and then a weak masonry filler wall is placed within this frame, a strong possibility arises that the concrete columns may fail in shear when the weak masonry fails in shear. Placing a weak masonry filler wall within a reinforced concrete frame may result in a weaker unit than without the filler wall.

STRONG MOTION SEISMOGRAPH RECORD

The strong motion seismograph record was provided by the Seismological Field Survey, United States Coast and Geodetic Survey, Environmental Science Services Administration, Department of Commerce, 390 Main Street, Room 2067, San Francisco, California 94105. This record was obtained from the United States-Peru Cooperative Station in Lima, Peru.

Attention is directed to the high frequency content of the accelerogram which was recorded approximately 380 km. (240 miles) from the epicenter. The top record is the vertical component, the middle record is the longitudinal, and the bottom record is the transverse. The directions of the horizontal, longitudinal and transverse records is not known at this time since the instrument was moved from its original installation. Preliminary analysis of the record indicates that the maximum acceleration recorded was approximately 1/10 G in Lima, Peru.

CCMS No. 9



U.S. COAST & GEODETIC SURVEY
STRONG MOTION SEISMOGRAPH RECORD
LIMA, PERU
EARTHQUAKE OF 31 MAY 1970. 20:23:27.3 G.M.T.

CCMS No. 9

THE AMERICAN ROLE IN DISASTER RELIEF

This booklet describing the help extended by the United States in cases of disasters abroad, was published in August 1970. It may be obtained from the address given below.

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LE ROLE DE L'AMERIQUE POUR L'AIDE EN CAS DE DESASTRES

Ce dépliant, publié en août 1970, décrit l'aide fournie par les Etats-Unis pour les désastres survenus hors de son territoire. Il peut être obtenu à :

Agency for International Development,
WASHINGTON, D.C. 20523,
U.S.A.

THE ALASKA EARTHQUAKE

A PROGRESS REPORT

279 Days of Federal Reconstruction Effort

This booklet may be obtained from:

Defence Printing Service,
WASHINGTON, D.C.

LE TREMBLEMENT DE TERRE EN ALASKA

UN RAPPORT DE SITUATION

279 jours de l'effort fédéral pour la reconstruction

Cet opuscule peut être obtenu à l'adresse ci-dessus

THE GREAT ALASKA EARTHQUAKE OF 1964

I. Economic Effects of the Earthquake

By George W. Rogers,
University of Alaska

Although value of property damaged and destroyed was high in relation to Alaska's population and income base, recovery of the economy following the great Alaska earthquake of 1964 was rapid and the activities engendered gave employment and income an important boost over previous levels. Since the 1940's, the Alaska economy has been based on government or government-related activities. In 1963, for example, 58 per cent of average monthly employment was in government (civilian and military) and only 5.8 per cent in commodity-producing industries other than construction. There was no need to restore the industrial plant, therefore, before the economy could resume functioning, and the largest private industry (construction) was immediately expanded. The effort was substantially financed or underwritten by the federal government. The emergency and reconstruction work completed between April 1964 and September 1966 pumped $321 million of new federal money into the Alaska economy, money which would not have been available in the absence of the disaster. The government of the State of Alaska received extra fiscal aid at a critical stage in its early career by the extension of the 5-year federal transitional-grants program provided under the 1959 Alaska Omnibus Act and by the establishment of the Federal Field Committee for Development Planning in Alaska.

The impact of the 1964 disaster on the total economy appeared to be beneficial, but this benefit differed among communities and areas within the state. As the principal and largest center of government and construction in the state, the Anchorage area benefited more than any other from the reconstruction activities. As the only major port of entry in operation immediately after the disaster, the Port of Anchorage captured the bulk of the freight movement into the south central and interior Alaska from the rival ports of Seward, Whittier, and Valdez, and retained this new business during the ensuing years. In contrast, despite rebuilding and substantial improvement of its port facilities, the population and economy of Seward underwent an immediate and continuing decline attributable to the 1964 disaster and to the aftermath of freight loss. Valdez gave no evidence of growth following its complete rebuilding at a new location. The natural-resource harvesting and processing communities in south central Alaska were either unaffected or made rapid recovery following the disaster. They may even have benefited from the replacement of obsolete gear and plant under favorable terms of financing.

II. Urban Planning in the Reconstruction

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Norman Williams, Jr.,
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Because of the need for immediate disaster relief and for rapid reconstruction following the earthquake, and in view of the limited resources in Alaska for handling these tremendous tasks, considerable federal aid was needed. This extensive aid was provided through existing programs, by special legislation, and through executive powers.

An effort was made while repairing the earthquake damage to plan, rebuild, and reorganize the area to make the damaged communities safer, economically sounder, and more attractive. Some of these efforts succeeded, but some were defeated by individual communities anxious to resume their customary activities with the minimum of delay.

As a generalization for the handling of disasters, the Alaska experience suggests that prevention, immediate relief, and long-term recovery should be considered separately. Efforts should be coordinated by a single state planning agency, with local and federal assistance.

The full report may be obtained from:

Printing and Publishing Office,
National Academy of Sciences,
2101 Constitution Avenue,
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PERU EARTHQUAKE

May 31, 1970

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This report may be available at:

Disaster Relief Coordinator,
Agency for International Development,
WASHINGTON, D.C.

AFTER ACTION REPORT
ALASKA GOOD FRIDAY EARTHQUAKE
27TH MARCH, 1964

Prepared for US Army Engineer Division North Pacific by the Alaska District January 1968

PART I

INTRODUCTION

1-01 AUTHORITY:

This after action report of the Alaska Good Friday Earthquake which occurred at 5:36 p.m. on 27 March 1964 in southwest Alaska has been prepared in accordance with paragraphs 73.60a and 73.60b of ER 500-1-1 and authority provided by letter ENGCW-OE dated 11 April 1966 from Office, Chief of Engineers.

1-02 SCOPE:

The report provides a consolidated coverage of the disaster assistance given by the Alaska District after the Alaska Earthquake. Included are cost summaries by agency, area, and by type of restoration. A comprehensive report on earthquake damage, restoration activities and technical information about the 1964 Alaska Earthquake is being prepared by the Alaska District for the National Academy of Sciences (NAS). It is the Alaska District's intention to finalize and bind the report and submit the same to the Chief of Engineers. Due to this NAS report, this after action report includes only certain topics and is not intended to cover completely the subject as the report would be as voluminous as the magnitude of the disaster indicates.

1-03 FEDERAL DISASTER ASSISTANCE:

Responsibility for disaster relief rests primarily with local and state governments. The Federal Government in case of natural disaster authorizes the Corps of Engineers' office in the area to use the resources at its command to aid civil authorities in preventing immediate human suffering, to mitigate destruction or damage to the public property of the United States, and to assist state and local governments in essential recovery operations. The Office of Emergency Planning (OEP) as the President's representative performs the function of directing and coordinating Federal disaster assistance. The Housing and Home Finance Agency, United States Geological Survey, Small Business Administration, United States Coast and Geodetic Survey, and others with type of assistance available are listed in Office of Emergency Planning publication.

"Types of Assistance Available to Alaska from Federal Departments and Agencies." The Federal Reconstruction and Development Planning Commission for Alaska was formed by the President on 2 April 1964 to coordinate the efforts of the Federal agencies and expedite the reconstruction of Alaska. Applicable public laws relating to disasters of this type are as follows:

a. Section 5 of the Flood Control Act of 18 August 1941, as amended by Public Law 99, 84th Congress and by Section 206 of the Flood Control Act of 1962 (33USC 701b), hereinafter referred to as Public Law 99.

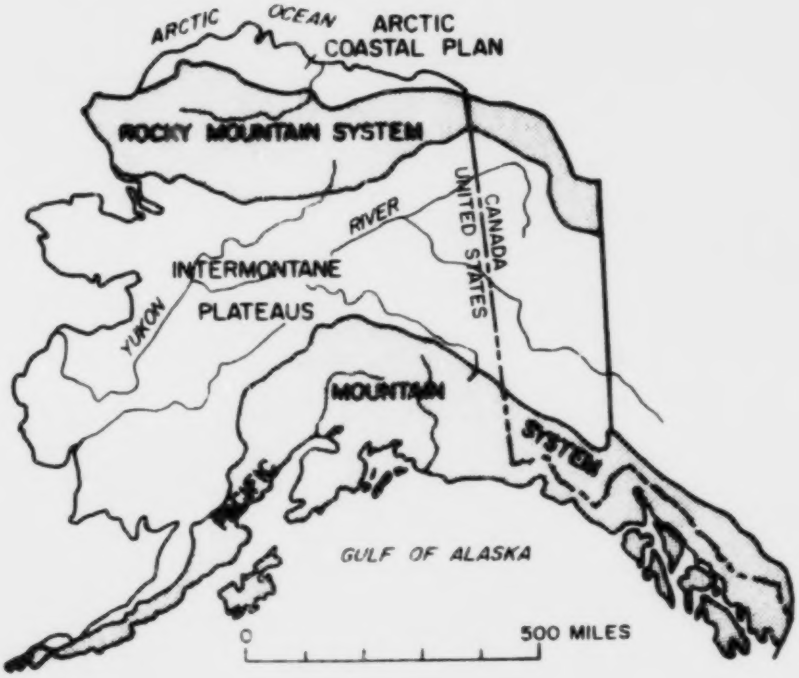
b. Public Law 875-81st Congress, Chapter 1125-2d Session, H.R. 8396, Federal aid in disasters.

PART II

EARTHQUAKE EFFECTS

2-01 GEOGRAPHICAL AREA

a. Alaska occupies the great northwestern peninsula of North America, which slopes and drains westward to the Bering and Chukchi Seas. Alaska may be divided into four major physiographic divisions: The Arctic Coastal Plain, the Rocky Mountain System, the Intermontane Plateaus and the Pacific Mountain System. Each division is a northwesterly extension of a major physiographic division of Canada and conterminous United States.


ARCTIC OCEAN
ARCTIC COASTAL PLAN
ROCKY MOUNTAIN SYSTEM
RIVER
CANADA
UNITED STATES
INTERMONTANE
PLATEAUS
YUKON
MOUNTAIN
SYSTEM
PACIFIC
GULF OF ALASKA
0
500 MILES

MAJOR PHYSIOGRAPHIC DIVISIONS OF ALASKA

Most of the State is mountainous or hilly although plains 20-100 miles wide abound. The central part, which slopes westward, consists of interspersed plains, plateaus, and rounded mountains, extending from beyond the Canadian border to the west coast; this part is bordered on the north and south by high rugged ranges which effectively cut off the bulk of the peninsula from the Arctic and Pacific Oceans.

The Arctic Mountains province of the Rocky Mountain System is the northern range, and is dominated by the Brooks Range with summit altitudes of 6,000 - 8,000 feet. The Arctic foothills, also part of the Rocky Mountain System, and the Arctic Coastal Plain, the northwestern extension of the Interior Plains, are north of this province. The southern mountain barrier, part of the Pacific Mountain System, is a pair of ridges separated by a line of discontinuous depressions, the Coastal Trough Province. The northern ridge of the pair is the Alaska - Aleutian Province; and the southern, the Pacific Border Ranges Province. Within the previously mentioned provinces are the highest peaks of North America, rising to an altitude of more than 20,000 feet. Mountains of 8,000 to 12,000 feet in altitude are not uncommon in these provinces.

The land between the Arctic Mountains and the Pacific Mountain System is a disordered assemblage of flat plains and rolling uplands, surmounted here and there by groups of low mountains. The whole region declines in altitude and relief toward the west. It is divided from east to west into five provinces: The Northern Plateaus Province, having uplands at altitudes of 3,000 - 5,000 feet, formed on crystalline and paleozoic rocks; the Western Alaska Province, having uplands at altitudes of 1,500 - 3,000 feet, formed on volcanic and late mesozoic sedimentary rocks; Seward Peninsula and the Ahklun Mountains, two distinctive relatively mountainous provinces; and the Bering Shelf, a nearly featureless plain, which is mostly submerged but has mountainous islands. Southeastern Alaska includes parts of the Coast Mountains, Coastal Trough, and Pacific Border Ranges; all provinces of the Pacific Mountain System.

The Yukon River, the largest river in Alaska, together with the Kuskokwim and other rivers which flow to the Bering and Chukchi Seas, drains all the Intermontane Plateaus and parts of the two mountain systems. The Bering-Chukchi-Arctic Ocean Divide is in the Arctic Mountains Province; and the Bering Sea-Pacific Ocean Divide is partly on the crest of the Alaska-Aleutian Province but for long stretches is in the lowlands of the Coastal Trough, where in places it follows eskers.

b. The earthquake was felt throughout nearly all of Alaska. For various reasons it was not felt in certain local areas distant from the epicenter. The level of intensity diminished appreciably northward from mountainous southern Alaska to the intermontane plateau of the interior. The geographic setting of the earthquake and land-level change was confined largely to the southernmost division of Alaska, the Pacific Mountain System. Damage was restricted generally to an area within about 150 miles of Prince William Sound.

c. Southern Alaska and the adjoining Aleutian Island chain constitute one of the world's most active seismic zones. The Alaska Seismic Zone is a part of an active seismic belt that circumscribes the Pacific Ocean Basin. It is believed that about 7 percent of the seismic energy released annually on the globe originates in the Alaskan Seismic Zone. This very active zone is circumferential to the Gulf of Alaska and lies parallel to the Aleutian Trench.

d. The earthquake damage assesment of the provinces of the Pacific Mountain System is as follows.

ALASKA-ALEUTIAN PROVINCE:

Little damage to manmade structures is known even though extensive ground cracking occurred in the alluvial flats of most rivers and some lake deltas of the Aleutian Range. Most of the Alaska Range was outside the area affected by the earthquake, although strong motion was felt north of the range and releveling suggests a possible uplift of nearly a foot (U. S. Coast and Geodetic Survey, 1965a, p.16).

COASTAL TROUGH PROVINCE:

The Coastal Trough Province sustained severe damage in the earthquake. Extensive damage to properties and manmade structures was a result of relatively high local population density and the behavior of certain Pleistocene formations that underlay part of the area. Landslides, subsidence, ground cracks, and vibrations were the chief causes of damage.

PACIFIC BORDER RANGES PROVINCE:

The Pacific Border Ranges Province contained the epicenter of the earthquake. Only the Kodiak Mountains, Kenai-Chugach Mountains, and the Gulf of Alaska coastal section were significantly involved in the earthquake. Most of Kodiak Island subsided during the earthquake. Many avalanches, snowslides and rockslides were caused by the earthquake.

GULF OF ALASKA COASTAL SECTION:

Avalanches, slides and slumps were associated with the earthquake.

2-02 SUMMARY OF DAMAGE:

At about 5:36 p.m., Friday, 27 March 1964, an earthquake rocked and jarred Alaska. This was to be the most violent earthquake to occur in North America this century, and has become renowned for its savage destructiveness, for its long duration, and for the great breadth of its damage zone. Its magnitude has been computed by the U. S. Coast and Geodetic Survey as 8.3 - 8.4 on the Richter scale. Another observation in Berkeley calculated its magnitude as 8.5 - 8.75. Few earthquakes in history have been as large. In just minutes, thousands of people were made homeless, over a hundred lives were lost, and the entire earth vibrated like a tuning fork. Seismic sea waves swept the Pacific Ocean from the Gulf of Alaska to Antarctica and caused extensive damage in British Columbia and California. Wave heights of 1 foot at Japan, and 7 feet at Hawaii were reported, but caused little damage. The Oregon coast was struck by 10 to 14-foot waves which killed a family of four and caused a minimum property damage of 500,000 dollars (Geological Survey Professional Paper 541, pg 37). In California 12 lives were lost at Crescent City and heavy property damage was sustained of which 1 million dollars occurred at San Rafael. Seiches were generated in various places remote from Alaska by amplification of direct seismic vibrations. The Gulf of Mexico off Texas was affected - waves damaged small craft.

Water level fluctuations were noted in wells throughout the continental United States and at Denmark, Puerto Rico, and the Virgin Islands.

Geologists have determined that the earthquake tilted an area of at least 52,000 square miles in south-central Alaska. East of a line extending northeastward from the southeast coast of Kodiak Island through the western part of the Prince William Sound, land masses were thrust up at local areas as high as 33 feet. To the west of this imaginary line, the land in some areas sank as much as 8 feet. Subsidence and uplift of the auto and rail routes along the coast line disrupted transportation facilities. Navigable waterways and harbors were damaged along with port facilities in some communities.

Most inland damage was caused by landslides, ground subsidence and fissures resulting from the violent ground motion of the earthquake.

Coastal area damage generally resulted from submarine landslides, slide-induced waves and tsunami effects.

Only the State's low population density prevented catastrophic loss of life and property.

Areas receiving major damage are listed hereinafter. Photographs of pre-earthquake, earthquake and wave damage, and restoration of certain major disaster areas are given in Part V of this report.

ANCHORAGE AND VICINITY:

Principal damage to the Anchorage area was caused by landslides, ground subsidence and fissures resulting from the earthquake. The city of Anchorage was not affected by tidal waves. Major destruction occurred in the main business district along Fourth Avenue; in the Turnagain Heights residential area overlooking Cook Inlet; in the K to L Street area west of the business district; and the Government Hill area adjoining Elmendorf Air Force Base. Damage to waterfront facilities was sustained, with both the City Dock and the Army Ocean Dock receiving major damage. The Army Dock was written off as a total loss.

CHENEGA:

Chenega was an Indian village on the south side of Chenega Island in Prince William Sound. The village consisted of 20 residences with a school on a hill behind the houses and about 82 inhabitants. The people obtained their living primarily from fishing. No deep draft docking facilities or float facilities for small boats had been built and the tide range for the waterfront was 20 feet as a maximum to a mean of about 8 feet.

The earth shocks did little damage to the village but the tsunami, which was estimated to be 80 feet high, took 25 lives and destroyed all the homes and buildings of the village except for the school house.

Immediately after the tsunami, the surviving residents of Chenega were transported to Cordova for food and shelter. It was decided that the village would not be rebuilt in the same location. The Bureau of Indian Affairs constructed new housing with force account labor for the surviving residents of Chenega at the village of Tatitlek.

CORDOVA:

Damage to the city resulted from earthquake-induced uplift of about 6 feet, local fracturing of the ground surface, and a tidal wave which floated boats, houses, destroyed pier and dock facilites, and damaged canneries.

KODIAK:

The damage to Kodiak occurred in three stages. The first stage was the earthquake itself; the second was a series of tsunamis that swept through the waterfronts and low lying areas of town; and the third was 100-knot winds occurring several days later.

Little damage occurred during the earthquake except for minor appurtenances, and an approximate 10-foot settlement of southwest breakwater and 6-foot settlement of the city.

The tsunamis following the earthquake caused the major loss of life and property. During the tsunamis 25 people were killed, the boat harbor destroyed, 40 percent of the business district destroyed, three of four canneries lost, the city dock damaged and 77 fishing boats destroyed, damaged or missing.

Three days after the earthquake, a storm with winds of around 100 knots hit the island during the night causing extensive damage to the remaining fishing fleet.

OLD HARBOR:

Old Harbor, an Indian village on the south side of Kodiak Island, received little damage from the earthquake directly. However, most of the homes were destroyed by the tsunami.

The day following the earthquake, the villagers were taken to the Kodiak Naval Station and then to Anchorage for temporary housing. New houses were constructed at Old Harbor by the villagers of both Kaguyak and Old Harbor, with materials which were furnished by the Red Cross and the Bureau of Indian Affairs.

SEWARD:

Submarine slides and tidal waves destroyed Seward's industrial area along the waterfront. The seismic shocks ruptured the petroleum products storage tanks and turned a half mile of waterfront into a flaming holocaust. The petroleum offloading facilities, canneries, municipal dock, railroad dock and other facilities along the waterfront were destroyed. The submarine landslides caused subsidence of about 4,000 feet of the waterfront and a 30-foot-high tidal wave was generated by the earthquake. Between the two destructive forces the industrial area along the waterfront was completely destroyed.

VALDEZ:

Valdez, located approximately 45 miles east of the earthquake epicenter, was the nearest civilian community to the epicenter. The pre-earthquake townsite was situated at tidewater on a glacial outwash plain at the head of the Valdez Bay. Ground shocks cracked buildings, opened fissures in the streets, and ruptured waterlines and sewerlines. The most catastrophic event experienced in Valdez was caused by the earthquake-induced submarine slide, and the resulting waves which virtually destroyed the waterfront structures, harbor, small-boat harbor, fuel storage terminal and half of the downtown business area. The submarine slide that destroyed the waterfront was estimated to be about 4,000 feet long and 600 feet wide. A hydrographic survey of the waterfront area after the slide shows the water depth at the dock face to be increased from 35 feet to 110 feet. An area near the small-boat basin formerly exposed at low tide, was covered with approximately 10 feet of water. Thirty lives were lost when the dock area disappeared and the waves generated by the slide swept onto the Valdez waterfront from the bay. Except for two fishing boats which were out to sea, the entire fishing fleet was destroyed.

In most communities the earthquake occurred at a time when the majority of the population in such communities were in transit from their jobs or schools. Unlike these communities, the dock at Valdez was in the full state of activity associated with the discharging of cargo from the Alaska Steamship Vessel, SS Chena, when the earthquake and resulting submarine slide occurred. A series of waves created further destruction to the waterfront structures and advanced into town causing additional property damage. The main area of property damage was confined to waterfront structures and the business district, which was located immediately shoreward of the waterfront structures. The Corps of Engineers under the sponsorship of the Office of Emergency Planning and others made studies and subsurface investigations of the area. The initial subsurface investigations substantiated the fact that the delta on which Valdez was situated consisted of saturated, fine outwash soil subject to liquefaction and sliding under seismic conditions. Based upon the investigations, the Scientific and Engineering Panel recommended to the Federal Reconstruction and Development Planning Commission that the town of Valdez be relocated to Mineral Creek Site. The recommendation was endorsed by the Federal and State Commissions, and a plan for relocation was presented to the city, which accepted the plan for reconstruction. The new site called the Mineral Creek Site is about 4 miles west of the old site.

WHITTIER:

Whittier, an ice-free seaport serving as a terminus for the Alaska Railroad, was virtually shut down prior to the earthquake. Damage was mostly due to a tsunami and fire that occurred on 27 March 1964. The commercial petroleum industry at the port was severely damaged as were the Alaska Railroad facilities. The emergency work consisted of the removal of debris caused by the earthquake. Restoration of the damaged railroad facilities was done by the Alaska Railroad.

CRESCENT CITY - CALIFORNIA

Crescent City bore the brunt of the wave damage in California. Twelve lives were lost, boats sunk, destroyed and missing, and heavy damage sustained by the harbor facilities, docks, and the seawall. Many homes and businesses were destroyed and damaged by the waves and following fires. The fifth seismic sea wave to arrive at Crescent City was the one which caused the damage and took all of the lives. This wave came in on a high tide and combined the natural high tide with the seismic sea wave to demolish the city.

PARTIAL LISTING OF INITIAL ESTIMATED EARTHQUAKE DAMAGE OF MAJOR DISASTER AREAS IS AS FOLLOWS:

a. FEDERAL AGENCIES

Air Force
  Elmendorf Air Force Base

Buildings & Structures	-	$ 9,298,700
Utilities & Streets	-	1,026,900
Coastal Installations	-	----
Airfields	-	696,200
Total		$11,021,800

Army	
Ft Richardson	
Buildings & Structures	$14,617,590
Utilities & Streets	650,000
Coastal Installations	400,000
Airfields	----
Total	$15,667,590
Port of Whittier	
Buildings & Structures	$ 2,888,000
Utilities & Streets	629,324
Coastal Installations	260,000
Total	$ 3,777,324
Wildwood	
Buildings & Structures	$ 193,000
Utilities & Streets	207,000
Total	$ 400,000
Seward	
Buildings & Structures	$ 157,075
Utilities & Streets	11,000
Coastal Installations	394,200
Total	$ 562,285
Ft Wainwright	
Buildings & Structures	$ 15,100
Utilities & Streets	44,450
Total	$ 59,550
Ft Greely	
Utilities & Streets	$ 1,100
Alaska Railroad	
Seward	
Coastal Installations	$ 7,800,000
Whittier	
Coastal Installations	$ 700,000
Seward to Anchorage	
Buildings & Structures	$ 2,050,000
Anchorage to Portage	
Buildings & Structures	$ 375,000
Utilities & Streets	5,000,000
Total	$ 5,375,000

Portage to Whittier

Buildings & Structures -	$ 50,000
Utilities & Streets -	300,000
Total	$ 350,000

Portage to Seward

Buildings & Structures -	$ 690,000
Utilities & Streets -	2,500,000
Total	$ 3,190,000

Anchorage to Palmer

Buildings & Structures -	$ 700,000
Utilities & Streets -	1,365,000
Total	$ 2,065,000

Palmer to Fairbanks

Buildings & Structures -	$ 350,000

General

Utilities & Streets -	$ 2,850,000

Total listed damage for Federal Agencies	$56,719,639

b. STATE OF ALASKA

City of Anchorage

Buildings & Structures -	$ 255,000

City of Seward

Buildings & Structures -	$ 300,000

Total listed damage for State of Alaska	$ 555,000

c. CITIES AND OTHER LOCAL AGENCIES

City of Anchorage

Buildings & Structures -	$38,783,000
Utilities & Streets -	9,112,000
Coastal Installations -	3,120,000
Airfields -	900,000
Total	$51,915,000

City of Cordova

Buildings & Structures -	$ 6,857
Coastal Installations -	687,845
Total	$ 694,702

City of Seward

Buildings & Structures	-	$13,499,544
Utilities & Streets	-	----
Coastal Installations	-	602,000
Airfields	-	5,000
Total		$14,106,554

City of Kodiak

Buildings & Structures	-	$ 2,655,062
Utilities & Streets	-	846,499
Coastal Installations	-	3,760,087
Airfields	-	1,897,931
Total		$ 9,159,579

Total listed damage for Cities and other Local Agencies	$75,775,835

d. PRIVATE

Anchorage & Vicinity

Buildings & Structures	-	$33,460,000

City of Cordova

Buildings & Structures	-	$ 39,780
Boats	-	166,000
Total		$ 205,780

City of Seward

Buildings & Structures	-	$ 439,000
Boats	-	301,000
Total		$ 740,000

Total listed Private damages	$34,405,780

e. SUMMARY OF EARTHQUAKE PROPERTY DAMAGE ESTIMATES

Public Property:

Federal:

Military	-	$ 35,610,000
Nonmilitary	-	35,641,000

Non-Federal:		
State & local	$107,373,000	
Highways	- 55,568,000	
		$234,192,000
Private Property:		
Real	- $ 77,000,000	
Personal	- (No Data)	
		$ 77,000,000
		$311,192,000

PART III

APPLICABLE AUTHORITIES AND ADMINISTRATIVE PROCEDURES

3-01 AUTHORITIES

a. Public Law 99, the administration of which is a Corps of Engineers' responsibility states:

> "That there is hereby authorized an emergency fund in the amount of $15,000,000 to be expended in flood emergency preparation; in flood fighting and rescue operations, or in the repair or restoration of any flood control work threatened or destroyed by flood, including the strengthening, raising, extending, or other modifications thereof as may be necessary in the discretion of the Chief of Engineers for the adequate functioning of the work for flood control; in the emergency protection of federally authorized hurricane or shore protection being threatened when in the discretion of the Chief of Engineers such protection is warranted to protect against imminent and substantial loss to life and property; in the repair and restoration of any federally authorized hurricane or shore protection structure damage or destroyed by wind, wave, or water action of other than ordinary nature when in the discretion of the Chief of Engineers such repair and restoration is warranted for the adequate functioning of the structure for hurricane or shore protection. The appropriation of such moneys for the initial establishment of this fund and for its replenishment on an annual basis is hereby authorized; provided, that pending the appropriation of said sum, the Secretary of the Army may allot, from existing flood control appropriations, such sums as may be necessary for the immediate prosecution of the work herein authorized, such appropriations to be reimbursed from the appropriation herein authorized when made. The Chief of Engineers is authorized, in the prosecution of work in connection with rescue operations, or in conducting other flood emergency work, to acquire on a rental basis such motor vehicles, including passenger cars and buses, as in his discretion are deemed necessary."

This law in coordination with Public Law 875 and administrative orders and regulations authorize use of PL 99 funds for restoration of Corps of Engineer facilities damaged in a natural emergency and support of disaster assistance requested by the Office of Emergency Planning.

b. Public Law 875 sets forth the condition under which Federal assistance can be provided to state and local governments upon declaration of a major disaster by the President of the United States. The law reads as follows:

"AN ACT

To authorize Federal assistance to States and local governments in major disasters, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That it is the intent of Congress to provide an orderly and continuing means of assistance by the Federal Government to States and local governments in carrying out their responsibilities to alleviate suffering and damage resulting from major disasters, to repair essential public facilities in major disasters, and to foster the development of such State and local organizations and plans to cope with major disasters as may be necessary.

Sec. 2. As used in this Act, the following terms shall be construed as follows unless a contrary intent appears from the context:

(a) "Major disaster" means any flood, drought, fire, hurricane, earthquake, storm, or other catastrophe in any part of the United States which, in the determination of the President, is or threatens to be of sufficient severity and magnitude to warrant disaster assistance by the Federal Government to supplement the efforts and available resources of States and local governments in alleviating the damage, hardship, or suffering caused thereby, and respecting which the governor of any State (or the Board of Commissioners of the District of Columbia) in which such catastrophe may occur or threaten certifies the need for disaster assistance under this Act, and shall give assurance of expenditure of a reasonable amount of the funds of the government of such State, local governments therein, or other agencies, for the same or similar purposes with respect to such catastrophe;

(b) "United States" includes the District of Columbia, Puerto Rico, the Virgin Islands, Guam, American Samoa, and the Trust Territory of the Pacific Islands;

(c) "State" means any State in the United States, Puerto Rico, the Virgin Islands, Guam, American Samoa, and the Trust Territory of the Pacific Islands;

(d) "Governor" means the chief executive of any State;

(e) "Local government" means any county, city, village, town, district, or other political subdivision of any State, or the District of Columbia, and include any rural community or unincorporated town or village for which an application for assistance is made by a State or local government or governmental agency.

(f) "Federal agency" means any department, independent establishment, Government corporation, or other agency of the executive branch of the Federal Government, excepting, however, the American National Red Cross.

Sec. 3. In any major disaster, Federal agencies are hereby authorized when directed by the President to provide assistance (a) by utilizing or lending, with or without compensation therefor, to States and local governments their equipment, supplies, facilities, personnel, and other resources, other than the extension of credit under the authority of any Act; (b) by distributing through the American National Red Cross or otherwise, medicine, food, and other consumable supplies; (c) by donating or lending equipment and supplies, determined under then existing law to be surplus to the needs and responsibilities of the Federal Government, to States for use or distribution by them for the purposes of the Act including the restoration of public facilities damaged or destroyed in such major disaster and essential rehabilitation of individuals in need as the result of such major disaster; and (d) by performing on public or private lands protective and other work essential for the preservation of life and property, clearing debris and wreckage, making emergency repairs to and temporary replacements of public facilities of States and local governments damaged or destroyed in such major disaster, providing temporary housing or other emergency shelter for families who, as a result of such major disaster, require tempotary housing or other emergency shelter, and making contributions to States and local governments for purposes stated in subsection (d). The authority conferred by this Act, and any funds provided hereunder shall be supplementary to, and not in substitution for, nor in limitation of, any other authority conferred or funds provided under any other law. Any funds received by Federal agencies as reimbursement for services or supplies furnished under the authority of this section shall be deposited to the credit of the appropriation or appropriations currently available for such services or supplies. The Federal Government shall not be liable for any claim based upon the exercise or performance or the failure to exercise or perform a discretionary function or duty on the part of a Federal agency or an employee of the Government in carrying out the provisions of this section.

Sec. 4. In providing such assistance hereunder, Federal agencies shall cooperate to the fullest extent possible with each other and with States and local governments, relief agencies, and the American National Red Cross, but nothing contained in this Act shall be construed to limit or in any way affect the responsibilities of the American National Red Cross under the Act approved January 5, 1905 (33 Stat. 599), as amended.

Sec. 5. (a) In the interest of providing maximum mobilization of Federal assistance under this Act, the President is authorized to coordinate in such manner as he may determine the activities of Federal agencies in providing disaster assistance. The President may direct any Federal agency to utilize its available personnel, equipment, supplies, facilities, and other resources, in accordance with the authority herein contained.

(b) The President may, from time to time, prescribe such rules and regulations as may be necessary and proper to carry out any of the provisions of this Act, and he may exercise any power or authority conferred on him by any section of this Act either directly or through such Federal agency as he may designate.

Sec. 6. If facilities owned by the United States are damaged or destroyed in any major disaster and the Federal agency having jurisdiction thereof lacks the authority or an appropriation to repair, reconstruct, or restore such facilities, such Federal agency is hereby authorized to repair, reconstruct, or restore such facilities to the extent necessary to place them in a reasonably usable condition and to use therefor any available funds not otherwise immediately required: Provided, however, That the President shall first determine that the repair, reconstruction, or restoration is of such importance and urgency that it cannot reasonably be deferred pending the enactment of specific authorizing legislation or the making of an appropriation therefor. If sufficient funds are not available to such Federal agency for use in repairing, reconstructing, or restoring such facilities as above provided, the President is authorized to transfer to such Federal agency funds made available under this Act in such amount as he may determine to be warranted in the circumstances. If said funds are insufficient for this purpose, there is hereby authorized to be appropriated to any

Federal agency repairing, reconstructing, or restoring facilities under authority of this section such sum or sums as may be necessary to reimburse appropriated funds to the amount expended therefrom.

Sec. 7. In carrying out the purposes of this Act, any Federal agency is authorized to accept and utilize with the consent of any State or local government, the services and facilities of such State or local government, or of any agencies, officers, or employees thereof. Any Federal agency, in performing any activities under section 3 of this Act, is authorized to employ temporarily additional personnel without regard to the civil-service laws and the Classification Act of 1949, as amended, and to incur obligations on behalf of the United States by contract or otherwise for the acquisition, rental, or hire of equipment, services, materials, and supplies for shipping, drayage, travel and communication, and for the supervision and administration of such activities. Such obligations, including obligations arising out of the temporary employment of additional personnel, may be incurred by any agency in such amount as may be made available to it by the President out of the funds specified in section 8. The President may, also, out of such funds, reimburse any Federal agency for any of its expenditures under section 3 in connection with a major disaster, such reimbursement to be in such amounts as the President may deem appropriate.

Sec. 8. There is hereby authorized to be appropriated to the President a sum or sums, not exceeding $5,000,000 in the aggregate, to carry out the purposes of this Act. The President shall transmit to the Congress at the beginning of each regular session a full report covering the expenditure of the amounts so appropriated with the amounts of the allocations to each State under this Act. The President may from time to time transmit to the Congress supplemental reports in his discretion, all of which reports shall be referred to the Committees on Appropriations and the Committees on Public Works of the Senate and the House of Representatives.

Sec. 9. The Act of July 25, 1947 (Public Law 233, Eightieth Congress), entitled "An Act to make surplus property available for the alleviation of damage caused by flood or other catastrophe", is hereby repealed.

Approved September 30, 1950."

c. Army

Repair and restoration work of earthquake damage for U. S. Army, Alaska was accomplished through normally established chains of command and through normal construction activities. The Alaska District continued the normal operations of the regular construction program while in addition making damage surveys and designing emergency works for U. S. Army, Alaska.

d. Air Force

Restoration work for the Alaskan Air Command was accomplished in the same method as projects for the normal Air Force construction program. The Alaska District designed emergency work and continued normal operations of the regular construction program while developing more deliberate design for some reconstruction programs.

e. Alaska Railroad

The Alaska District Corps of Engineers accomplished reconstruction work for the Alaska Railroad on a reimbursable basis. The same reimbursable work order procedure was used as was used for the work being done for Office of Emergency Planning. Official authorization for advance planning and design work was given on Seward dock and other related facilities of the Alaska Railroad in letter dated 9 June 1964 from the Assistant Secretary of the Interior to the Secretary of the Army.

f. Alaska State Housing Authority

The Alaska State Housing Authority, acting as agent for the Urban Renewal Administration of the Housing and Home Finance Agency, requested the Alaska District to be the design and construction agency for specific urban renewal projects. The Corps of Engineers, Alaska District, proceeded with urban renewal work immediately upon receipt of individual directives from ASHA.

3-02 MISSION ASSIGNMENTS

Corps of Engineers

Flood fighting repair and restoration are normal operations of the Corps of Engineers. This type of work is carried out utilizing funds provided by Public Law 99 and Operations and Maintenance, General Appropriations.

The Corps of Engineers was formally requested to assume the responsibility for repair and restorative work in the disaster area within the purview of Public Law 875 by letter dated 31 March 1964 from the Director, Office of Emergency Planning, Executive Office of the President, Washington, D. C. The Alaska District, Corps of Engineers, was requested to proceed with the repair and restorative work through its personnel, upon receipt of individual directives from OEP. The directives from OEP Region 8 at Everett, Washington were initiated as a result of requests from public entities, and sent to the Alaska District for action through North Pacific Division Corps of Engineers. Similar requests utilizing other funds were received from the Department of Interior, Alaska Railroad, the Alaskan Air Command, the U. S. Army Alaska, and Alaska State Housing Authority acting for the Urban Renewal Administration.

Mission assignments to the Corps of Engineers by the Region 8, Office of Emergency Planning, in general consisted of the following:

(1) Providing technical assistance, execution of surveys, and submission of reports to the OEP Regional Director.

(2) Emergency repair to and temporary replacement of public facilities, except as reserved to other Federal agencies.

(3) Debris and wreckage clearance.

(4) Performing protective and other work essential for the preservation of life and property.

The District's operations in connection with Public Law 875 are conducted primarily as civil works activities. Professional and administrative judgments are required to determine the eligibility of projects under this law. Public Law 875 relates to emergency repairs and temporary replacement and to provide Federal assistance to alleviate damage, hardship, and suffering brought about by a disaster; but this law is not intended to provide for improvement or betterment.

3-03 ADMINISTRATIVE ASSIGNMENTS

a. Organization and Mobilization

The Alaska District requested engineers from North Pacific Division for damage survey teams. Some 65 engineers for emergency disaster teams were sent to Alaska from the

Walla Walla, Seattle, and Portland Districts to survey damages, and to help in the development of cost estimates and scope of specific projects to be repaired.

The Alaska District also negotiated with architect-engineer firms to execute the design projects defined by the survey teams. A cost-plus-fixed-fee contract was negotiated with a master architect-engineer firm to augment the staff of the Engineering Division so as to insure that designs conformed to both Federal and State standards and met the needs of the communities. The Alaska District organized three new Resident Engineer Offices, one at Anchorage, one at Valdez, and one at Seward, and a number of project offices at the smaller towns to maintain close contact with the communities in developing projects.

Construction contracts were put out in successive increments as much as possible to allow the maximum participation by local bidders. This approach permitted the Corps and architect-engineers to produce bidding documents earlier than if large segments of work were included in one contract. This was an effective way of increasing needed employment and channeling as much of the restoration work as possible to the hard-hit local residents. One of the major problems in every community, and particularly in the smaller ones, was the serious disruption of the local economy. By reducing work to small contracts, the local economy was assisted and some savings of time in accomplishing the assigned mission was achieved.

b. Coordination with other Agencies

Close coordination was involved between the Alaska District and the Office of Emergency Planning during the Corps' task of furnishing the engineering support requested by the Office of Emergency Planning. This support included supervision and administration of construction contracts and support for all types of Public Law 875 work. The Office of Emergency Planning submitted 20 separate work orders to the Corps for various disaster assistance projects.

As was previously mentioned, restoration of projects for the Alaskan Air Command and for the U. S. Army, Alaska was accomplished through normal established chains of command as are done for projects in the regular construction program for each agency.

Work and coordination between the Alaska Railroad and the Corps was accomplished by separate work order procedures, in much the same way as was done for OEP.

Extensive coordination with the Alaska State Housing Authority was necessary to complete urban renewal restoration. Most urban renewal projects required extremely close coordination due to the complex scheduling of demolition of structures to be removed. Also, close coordination was necessary to incorporate the cities' or other political identities' desires, if the desires were within URA regulations.

The Corps of Engineers provided extensive technical and administrative help for the task forces committees and for the Federal Reconstruction and Development Planning Commission. The Federal Commission was set up by President Johnson to develop coordinated plans and recommendations for the reconstruction and economic development of Alaska. The composition of the Commission was conceived so it facilitated design making with a Member of Congress, agency heads and Cabinet Officers working closely together. Both legislative recommendations and major policy decisions by departments and agencies could be agreed to at Commission meetings. After agreements were reached at Commission meetings the members of the Commission had authority to act with broad areas of responsibility without further approvals. Thus, the time involved in the normal process of interagency and Bureau of the Budget clearance of proposed legislation was drastically reduced. On 7 April, the Federal Commission established the Alaska Field Committee. This committee provided coordination at the field level for those problems which cut across agency lines of responsibility. The membership was composed of representatives of agencies serving on the Federal Commission which had staffs in Alaska. Of the task teams, the Corps of Engineers participated in the following: National Resources Development, Ports and Fishing, Scientific and Engineering, and Scientific and Engineering Field Team.

PART IV

EMERGENCY RECOVERY

4-01 DAMAGE SURVEYS

The immediate problem posed by the earthquake was to determine the extent of damages to civilian communities, military installations and transportation facilities. Engineer disaster teams were organized to survey the damage and furnish guidance for emergency restoration to insure public safety, maintain health and to restore communications. Survey teams were sent in light aircraft and wheeled vehicles to check on all communities affected by the earthquake. It became apparent immediately after the earthquake that the Alaska District did not have sufficient engineering personnel to survey the damage, perform the design for earthquake restoration and to carry on the normal workload of military and civil works projects.

Damage survey personnel were requested from Corps of Engineers' offices to help with the earthquake. A disaster survey team of engineers headed by William E. Schaem from the Office Chief of Engineers made a survey of damage to military construction in Alaska. The list of the team members is given in Appendix VII.

It was decided that all earthquake restoration design would be done by architect engineers (A-E). Preparation of criteria packages for negotiation with A-E also presented a major task beyond Alaska District engineering resources. The well qualified engineering firm of Metcalf and Eddy (M&E) of Boston, Mass. was engaged on a cost-plus-a-fixed-fee A-E contract to supplement the Engineering Division's capability. Metcalf and Eddy assembled a particularly well qualified group of engineers, peaking at about 50, under the supervision of Brigadier General B. B. Talley (USA retired) a senior associate in the firm. This organization performed very well, making a significant contribution to the total earthquake restoration effort.

Of the public and private structures, particular emphasis was placed on damage assessment of the many schools in the affected communities. Several schools suffered severe structural damage and were declared to be unsafe. Lightly damaged or undamaged schools were occupied only on verification of the structural adequacy by the staff of the Alaska District.

4-02 INVESTIGATIONS

A vital part of the program was the assembly of adequate technical information to serve as a basis for engineering decision making. Because of the extensive earthquake-induced slides, it was felt that a major soils, geology, and foundation study of these landslides would be needed. An investigation of the landslides and other earthquake damage was initiated on 29 March 1964 by the Anchorage Engineering Geology Evaluation Group under authorization of the Alaska State Housing Authority and the city of Anchorage. In Anchorage, an operational organization was selected which consisted of an architect-engineer group to function under the supervision of the Alaska District's engineering staff. This group was to investigate and report to the Alaska District, along with a board of consultants.

A consultant on soils mechanics and foundations (Shannon and Wilson, Inc., of Seattle) was hired to augment the staff in supervising the programing of soils studies. The studies required the drilling of holes, and testing samples taken from various localities including the slide areas of Anchorage, Seward, and Valdez.

The board of consultants consisted of eminent soils and geology experts which was constituted to monitor and review the progress and direction of the soils and geology studies of the Alaska District and the district's foundations contractor, and to advise the District on the course of action to be undertaken. The Board was composed of Dr. Ralph B. Peck of the University of Illinois, Dr. Laurits Bjerrum, director of the Norwegian Geological Institute, and Thomas F. Thompson of Burlingame, California. Dr. H. B. Seed of the University of California under contract with the firm of Shannon and Wilson, attended the board meetings and gave considerable assistance. Mr. Stanley D. Wilson of the firm Shannon and Wilson was present at many of the meetings and aided in the decisions. Dr. Leo Casagrande, of the Harvard University, gave assistance in electro-osmosis investigations on stabilization efforts for Turnagain Slide.

The work of the investigation was voluminous and of a great variety, and it resulted in comprehensive engineering data on each slide and surrounding area. Subsurface profiles were developed from some 150 borings and other explorations and tests. Comprehensive laboratory investigations were conducted.

The information received from the Alaska District and others enabled the Scientific and Engineering Field Team

(Task Force Nine) to determine and revise risk area classifications on land in or near landslide areas. Risk classifications were changed as additional information was received, and were published in the newspapers along with a semitechnical explanation of the Alaska District's findings concerning stability and restoration of the landslide areas. The Office of Emergency Planning along with the Alaska District also utilized the findings as background for important engineering decisions as to restoration of public facilities and for stabilization in each landslide area.

Shannon and Wilson's report of 28 August 1964 presents the results of the investigation in detail, gives explanations as to reasons for what occurred: and makes final recommendations as to design criteria for remedial measures and land uses. A summary of the conclusions are as follows:

(1) The strong ground motion waves from the earthquake-generated shear stresses in the upper critical soils of the Bootlegger Cove Clay, which underlies parts of Anchorage, caused failure in these soils and permitted horizontal sliding toward the bluffs in locations where height, declivity, and other physical parameters were most unfavorable to stability.

(2) Though all slide areas are stable under present static conditions, all may be expected to experience additional movements of varying magnitudes in another great earthquake.

(3) All areas which failed can be stabilized against another earthquake of similar magnitude and duration by means of slope flattening, buttressing, improvement of subsurface drainage, and other well established procedures.

(4) Settlement of the ground surfaces, in and adjacent to the slide areas, will occur over a period of years due to consolidation of the slide distributed clay and sand strata, especially within the graben and pressure ridge parts.

(5) Many of the bluff slopes in the vicinity of Anchorage underlain by the Bootlegger Cove Clay are of marginal static and dynamic stability, and oversteepening or overloading of existing slopes by excavations at the base or by construction of fills or heavy structures near the crest or on the slope may result in localized landslides.

(6) Ground motions during earthquakes will likely be greater near the crest of such slopes than elsewhere.

Engineering firms were employed by contract for inspection of water and sewer systems in order to obtain data on which to base the design for restoration and reconstruction.

It was necessary to depend upon visual inspection for accomplishment of the more urgent repairs on an emergency basis. Later a more sophisticated inspection was accomplished.

4-03 RECOVERY

a. Demolition and Cleanup

Demolition of damaged, unrepairable structures and the clearance of debris and wreckage from disaster affected areas were begun immediately. Due to short construction season and severity of Alaskan winters, rapid demolition and cleanup was essential so as to clear areas for reconstruction. Since ground surface freezing in the Anchorage area occurs around 15 October to 20 October, speed in demolition and cleanup was essential before freezeup.

b. Utilities

Procedures for testing of certain water lines were included in the provisions of the contracts for inspection, and test requirements were established on the same basis as would be used for new construction. Acceptance of lines, tested on this basis, gave the communities assurance that the repaired system would be as trouble free as possible.

The determination of the location of damage and the delineation of repair methods for sewer restoration was more complex than was the case with the water distribution system. Damage to sewers was not confined to slide areas nor was damage obvious at the ground surface as is often the case with breaks in water lines. Photographic and direct visual inspection of the sewers were employed to determine the location and nature of individual line breaks. Manholes were inspected at the same time that camera crews were using them for access to the sewer. Photographs were made at 30-inch intervals along the pipe in all storm and sanitary sewers smaller than 24 inches where damage was suspected to exist, and direct visual inspection was undertaken in all such sewers 24 inches and larger.

Flushing and cleaning of sewers prior to inspection was required, and some cleaning with "porcupines" and buckets was found to be necessary. It was also found necessary to employ pumping to lower the hydraulic gradient and to bypass some of the sewage flow in heavily loaded sewers. Approximately 700,000 linear feet of storm and sanitary sewers were inspected by contract in the Anchorage area alone, during the summer of 1964. Photography was of two types, one being the "inspectoline" process, in which a 16 mm single-frame automatic camera with stroboscopic flash equipment was used. This equipment is suitable for pipelines 8 inches and larger. It was found that color film gave better results than black and white film. The other method utilized a 35 mm double-frame stereoscopic automatic camera, equipped with stroboscopic flash equipment and a heating device to prevent lens fogging, producing black and white stereo-paired photographs of excellent quality.

PART V

RESTORATION

5-01 RESTORATION

Immediately after the emergency restoration projects were completed, the Alaska District along with other agencies who participated in the restoration effort followed a plan for reconstruction initiated by the Federal Reconstruction and Development Planning Commission for Alaska. Due to the short construction season and the severity of the Alaskan winters, the Commission carefully coordinated critical reconstruction project planning. The representatives of the commission worked closely with the Office of Emergency Planning and with the Department of Defense personnel in expediting work schedules, but also attempted to avoid placing all work in a crash basis in order to lessen inflation, discourage the importation of non-Alaskan labor and pace the reconstruction period for noncritical work. The pattern plan was followed by the district in order to strengthen the Alaskan economy. The plan was first, to make emergency repairs to the utilities and highways; second, to make geologic and soils studies; third, to design projects; and last, to award contracts. In order to expedite the reconstruction, design of the projects many times paralleled the soils studies.

During this period, almost every step was reduced in time under that normally required.

Top priority was given to the restoration of water and sewer systems. Irrigation pipes were laid above ground and garden hoses connected to houses as a temporary water system in many areas. All major breaks in sewer and water lines were repaired before the Alaskan winter arrived.

Reconstruction of port facilities was given a priority second only to that of water and sewers. Almost all of the goods going to and from central Alaska pass through the port facilities.

Repair of the schools was another major and critical area of work that was needed before winter set in. Almost all of the schools were repaired in time for the 1964 fall term. However, where new permanent buildings were required, completion was scheduled for the fall of 1965.

A comprehensive report on earthquake damage, restoration activities and technical information about the 1964 Alaska Earthquake is currently being prepared by the Alaska District for the National Academy of Sciences (NAS). The Alaska District will finalize and bind the report and submit the same to the Chief of Engineers. Chapter titles of subjects included in NAS report and report submitted to Chief of Engineers are included in Appendix II.

The Alaska District had a special interest in the restoration of the small-boat basins. The boat basins had been designed and constructed by the Corps of Engineers, so when restoration was required the Alaska District gave immediate attention to rebuilding the installations. Before the earthquake occurred several basins required additional moorage space. Therefore, at the time of restoration of the small-boat basins, which required extensive construction, additional Corps of Engineers funds were allocated to enlarge the basins. About two million dollars was spent for this expansion work. Restoration of all the small-boat basins was performed by the Alaska District under the Office of Emergency Planning authorization.

General description of the restoration of the major damaged areas is as follows. Immediately following the restoration description of each major damaged area are photographs depicting pre-earthquake, earthquake and/or wave damage, and restoration conditions.

ANCHORAGE AND VICINITY:

Restoration of underground utilities, as well as all of the schools that had light to moderate damage were repaired by construction contracts in time for the beginning of the fall sememster in 1964. Denali Elementary School, which had heavy damage, was available for use at the beginning of the second sememster. West Anchorage High School, which was very heavily damaged, required extensive repair. The moderatly damaged auditorium wing was first restored, in time for use by the school for the first sememster of 1964. Next came the restoration of the severely damaged classroom wing, which was ready for used for the second semester. A new one-story classroom wing was then constructed to replace the destroyed second story of the school. The Government Hill Elementary School, which was destroyed by an earthslide, could not be rebuilt in the same location because of unstable soil conditions. A new school was built and ready for occupancy by August 1965.

Repair of underground utilities also had priority. Surface waterlines were laid immediately after the earthquake so as to provide service in the major slide areas. Essential permanent restoration of water service in all areas was completed well before freezeup, and the temporary surface lines were then dismantled. New wells to replace those destroyed were drilled so as to assure a continued dependable water supply.

Upon completion of soils investigation and review by the Board of Consultants, it became apparent that stabilization of the major slide areas would have to be accomplished, not only to restore the areas to use, but also to protect adjacent property. Due to this the Fourth Avenue slide area was to be stabilized by use of a buttress system. The project was expanded to include the construction of a new utility and street system. The Turnagain slide area posed a problem. Blasting and mechanical stabilization methods became unattractive when drawbacks developed while attempting to consolidate the sensitive clay. Electro-osmosis was then attempted. A test model consisting of 22 railroad rails as probes introducing direct current at varying voltage and amperages to the clay has been to some degree successful in increasing soil strength.

Although some of the experiments were to some extent promising, it was found that the slide material was gaining strength without outside help. Most of the slide material has now gained a greater part of its original strength. Due to the findings, the Alaska District decided that stabilization measures, other than protection of the shoreline, were unnecessary.

Street repairs were deferred until utility repair which required the removal of pavement was complete. All pavement restoration was completed by August 1965.

HISTORY AND TYPE OF EARTHQUAKES IN ITALY DURING THE LAST TEN YEARS

(See/voir pages 5.1 to/à 5.40)

CCMS No. 9

ITALIAN DISASTER ASSISTANCE REGULATIONS APPLYING TO DAMAGES CAUSED BY EARTHQUAKES TO AGRICULTURAL ENTITIES

REGLEMENTS ITALIENS POUR L'AIDE EN CAS DE DESASTRE CONCERNANT LES DEGATS CAUSES PAR LES TREMBLEMENTS DE TERRE

par le Dr. Mezzacapo Raffaele

Information may be obtained from the address given below:

Des informations peuvent être obtenues à:

Ministero dell'Agricoltura e delle Foresté
Direzione generale dei miglioramenti
fondiari e dei servizi speciali,
Divisione VI REAA,
ROMA,
Italia.

THE ALASKA EARTHQUAKE, MARCH 27, 1964: LESSONS AND CONCLUSIONS

By Edwin B. Eckel

ABSTRACT

One of the greatest earthquakes of all time struck south-central Alaska on March 27, 1964. Strong motion lasted longer than for most recorded earthquakes, and more land surface was dislocated, vertically and horizontally, than by any known previous temblor. Never before were so many effects on earth processes and on the works of man available for study by scientists and engineers over so great an area.

The seismic vibrations, which directly or indirectly caused most of the damage, were but surface manifestations of a great geologic event—the dislocation of a huge segment of the crust along a deeply buried fault whose nature and even exact location are still subjects for speculation. Not only was the land surface tilted by the great tectonic event beneath it, with resultant seismic sea waves that traversed the entire Pacific, but an enormous mass of land and sea floor moved several tens of feet horizontally toward the Gulf of Alaska.

Downslope mass movements of rock, earth, and snow were initiated. Subaqueous slides along lake shores and seacoasts, near-horizontal movements of mobilized soil ("landspreading"), and giant translatory slides in sensitive clay did the most damage and provided the most new knowledge as to the origin, mechanics, and possible means of control or avoidance of such movements. The slopes of most of the deltas that slid in 1964, and that produced destructive local waves, are still as steep or steeper than they were before the earthquake and hence would be unstable or metastable in the event of another great earthquake. Rockslide avalanches provided new evidence that such masses may travel on cushions of compressed air, but a widely held theory that glaciers surge after an earthquake has not been substantiated.

Innumerable ground fissures, many of them marked by copious emissions of water, caused much damage in towns and along transportation routes. Vibration also consolidated loose granular materials. In some coastal areas, local subsidence was superimposed on regional tectonic subsidence to heighten the flooding damage. Ground and surface waters were measurably affected by the earthquake, not only in Alaska but throughout the world.

Expectably, local geologic conditions largely controlled the extent of structural damage, whether caused directly by seismic vibrations or by secondary effects such as those just described. Intensity was greatest in areas underlain by thick saturated unconsolidated deposits, least on indurated bedrock or permanently frozen ground, and intermediate on coarse well-drained gravel, on morainal deposits, or on moderately indurated sedimentary rocks.

Local and even regional geology also controlled the distribution and extent of the earthquake's effects on hydrologic systems. In the conterminous United States, for example, seiches in wells and bodies of surface water were controlled by geologic structures of regional dimension.

Devastating as the earthquake was, it had many long-term beneficial effects. Many of these were socioeconomic or engineering in nature; others were of scientific value. Much new and corroborative basic geologic and hydrologic information was accumulated in the course of the earthquake studies, and many new or improved investigative techniques were developed. Chief among these, perhaps, were the recognition that lakes can be used as giant tiltmeters, the refinement of methods for measuring land-level changes by observing displacements of barnacles and other sessile organisms, and the relating of hydrology to seismology by worldwide study of hydroseisms in surface-water bodies and in wells.

The geologic and hydrologic lessons learned from studies of the Alaska earthquake also lead directly to better definition of the research needed to further our understanding of earthquakes and of how to avoid or lessen the effects of future ones. Research is needed on the origins and mechanisms of earthquakes, on crustal structure, and on the generation of tsunamis and local waves. Better earthquake-hazard maps, based on improved knowledge of regional geology, fault behavior, and earthquake mechanisms, are needed for the entire country. Their preparation will require the close collaboration of engineers, seismologists, and geologists. Geologic maps of all inhabited places in earthquake-prone parts of the country are also needed by city planners and others, because the direct relationship between local geology and potential earthquake damage is now well understood.

Improved and enlarged nets of earthquake-sensing instruments, sited in relation to known geology, are needed, as are many more geodetic and hydrographic measurements.

Every large earthquake, wherever located, should be regarded as a full-scale laboratory experiment whose study can give scientific and engineering information unobtainable from any other source. Plans must be made before the event to insure staffing, funding, and coordination of effort for the scientific and engineering study of future earthquakes. Advice of earth scientists and engineers should be used in the decision-making processes involved in reconstruction after any future disastrous earthquake, as was done after the Alaska earthquake.

The volume closes with a selected bibliography and a comprehensive index to the entire series of U.S. Geological Survey Professional Papers 541–546.

Available by the Superintendent of documents, US Government Printing Office, Washington DC 20402. Library of Congress, catalog card no. 70-604792.

Rétablissement des Services Essentiels

par l'Ing. Arrigo Fratelli

Le tremblement de terre est la calamité naturelle la plus grave pour une communauté soit à cause de l'imprévisibilité du phénomène soit à cause de ses larges proportions.

Généralement les interventions des autorités publiques chargées du prompt secours aux sinistrés sont ainsi échelonnées:

(a) prompt secours aux sinistrés;

(b) rétablissement des services publics essentiels;

(c) reconstruction définitive.

(a) Aux termes de la loi du 8 décembre 1970 n°996 qui règle l'organisation du prompt secours et de l'assistance aux sinistrés, si l'étendue de la calamité exige des moyens techniques extraordinaires, le gouvernement nomme un Haut Commissaire chargé de donner les directives principales et de coordonner tous les services civiles et militaires de secours et d'assistance aux populations.

Les problèmes à résoudre dans cette première phase sont: transporter les blessés aux postes de premier pansement ou aux hôpitaux des villes les plus proches, récupérer les cadavres, dresser des tentes pour les sans-toits où loger les sinistrés dans des bâtiments publics (casernes, écoles) et hôtels réquisitionnés pour la circonstance.

Les services du Ministère des Travaux pourvoient à décombrer les rues du centre afin de récupérer les blessés et les cadavres ainsi qu'à démolir les structures instables des bâtiments donnant sur les principales routes de liaison du centre endommagé avec les villes voisines.

Le Gouvernement émet des mesures en faveur des sinistrés, à savoir subventions extraordinaires, dispenses d'impôts, facilitations diverses afin d'encourager la reprise des activités économiques.

(b) Cette première phase terminée, il faut pourvoir d'urgence à assigner aux sinistrés des logements convenables et proportionnés aux exigences de chaque famille, même ayant un caractère provisoire. De cette façon se développera une agglomération urbaine constituée de baraques où la population logera durant une période minimum de 4 à 5 ans.

En effet la troisième phase concernant la reconstruction définitive demande un temps technique non inférieur à un quinquennium, étant nécessaire créer des nouvelles villes harmonieusement insérées dans le contexte territorial ou bien restructurer, même partiellement, le vieux centre.

(c) Le Ministère des Travaux Publics établit les plans d'urbanisation et, en ce qui concerne les habitations, des subventions sont octroyées aux particuliers qui reconstruisent de leur propre initiative dans le cadre du plan approuvé.

Cela dit, nous traiterons, en particulier, les interventions de la deuxième phase c'est-à-dire le rétablissement des services publics essentiels.

Cette transition présente des problèmes particulièrement sérieux parce qu'il s'agit de donner aux sinistrés, dans le delai le plus bref, un logement convenable, même si provisoire, afin que soit rempli le devoir social de restituer les victimes de la calamité à leurs occupations traditionnelles.

De cette façon, le sinistré cesse d'être un bénéficiaire perpétuel de l'Assistance publique ou de l'aide privée et devient de nouveau un citoyen autonome capable de jouer son rôle dans la société.

La réalisation des baraques ne doit pas être improvisée, mais doit suivre des méthodes bien établies, à savoir:

- Enquête statistique générale;
- Enquête technique sur les services préexistants;
- Choix des terrains destinés à l'installation des baraques;
- Oeuvres d'aménagements;
- Mise en place des baraques.

ENQUETE STATISTIQUE GENERALE

Cette enquête doit assurer l'acquisition des données suivantes:

- Nombre et composition des familles sinistrées; cette donnée est fondamentale pour établir le nombre et la grandeur de logements provisoires nécessaires;
- Types d'écoles et nombre de classes à rétablir;
- Bureaux publics (Mairie, P.T.T., Police, etc.);
- Eglises;
- Centres sociaux;
- Exercices commerciaux (alimentaire, habillement, pharmacie, etc.);
- Ateliers.

Sous tous les aspects, il serait utile que les recensements nationaux pour les centres habités, aboutissent à la rédaction de "mappes de la population" avec analogie aux mappes du cadastre des terrains. De cette façon, comme les mappes du cadastre mettent en évidence les cultures (pâturages, vignobles, vergers, etc.) ainsi les "mappes de la population" composées de parcelles de grandeur différente pourraient mettre en évidence nombre et composition des familles, profession ou métier du chef de famille, exercices commerciaux, ateliers, écoles, etc.

Un recensement ainsi conçu serait très utile pour tous les plans d'aménagement et pour l'acquisition des connaissances dans les domaines plus variés (commerce, impôts, santé, etc.), mais spécialement dans les cas de grande urgence, comme la construction des baraques, réduirait sensiblement la durée de la susdite enquête statistique générale et fournirait des résultats certains.

ENQUETE TECHNIQUE SUR LES SERVICES PREEXISTANTS

Cette enquête doit tendre à l'acquisition des données suivantes:

- Besoin en eau de la population, diamètre de la conduite d'adduction et état de conservation de l'équipement, altitude du captage, nombre et état de conservation des réservoirs;
- Sections des égouts utilisables, points de déversement et état de conservation des équipements d'épuration;
- Lignes électriques à voltage moyen, transformateurs et énergie délivrée aux usagers.

CHOIX DES TERRAINS DESTINES A LA CONSTRUCTION DES BARAQUES

Il faut étudier attentivement la position des terrains disponibles pour la mise en place des baraques et des services relatifs, en tenant compte de l'opportunité de situer l'ensemble des baraques à proximité du vieux centre pour les motifs suivants:

- Utilisation des principales conduites d'eau, des égouts et des lignes électriques encore en bon état de conservation;
- Utilisation de la viabilité préexistante;
- Proximité du préexistant lieu de travail;
- Nécessité de favoriser les liens sentimentaux de la population à l'égard du vieux centre.

La surface nécessaire à la mise en place des baraques doit être calculée en raison de 200 m2 pour chaque logement provisoire, y compris la surface du logement même. Ce standard est le minimum indispensable pour la création de la viabilité intérieure, parking, terrains de jeux, établissements sociaux et appartenances aux bureaux publics.

Sont à préférer les terrains plats pour éviter mouvements de terre et oeuvres de soutènement; dans tous les cas la construction des remblais est absolument défendue. En effet, les remblais, subissent des affaissements naturels ou provoqués par les pertes des réseaux et par les infiltrations des eaux de pluie: ces affaissements engendrent des dégâts dans les ossatures des baraques.

Le terrain choisi doit avoir aussi une bonne exposition et ne doit pas être traversé par des lignes électriques à haute tension, fossés, canalisations, etc. etc.

Il est recommandable aussi d'éviter les grands rassemblements de baraques qui pourraient rappeler les camps de concentration, cela produirait des conséquences psychologiques absolument négatives sur les sinistrés.

OEUVRES D'AMENAGEMENT

Les oeuvres d'aménagement des baraques comprennent la viabilité intérieure et les liaisons avec le réseau des routes existantes, les conduites d'eau, les égouts, les lignes électriques.

La viabilité intérieure doit permettre les liaisons parmi les baraques rassemblées en groupes de 10 à 15 logements, opportunément surélevés afin d'empêcher la circulation des véhicules dans les espaces libres à proximité des habitations.

Les pentes longitudinale et transversale des rues doivent être attentivement étudiées pour garantir un rapide écoulement des eaux et éviter l'existence de points bas. Le revêtement des rues sera au goudron et au bitume pour faciliter l'écoulement des eaux et éviter la formation de poussière.

Autant que possible, le réseau doit être maillé. On évite ainsi la stagnation de l'eau dans les extrémités des conduites, chaque point du réseau est alimenté de deux côtés, et la coupure d'une conduite ne provoque pas autant d'inconvénient qu'avec un réseau palmé. La sécurité de l'alimentation en eau en cas d'incendie est donc plus grande. Le réseau maillé facilite la distribution quand l'approvisionnement ne peut pas être assuré tous les jours.

Pour la lutte contre l'incendie on doit employer des prises d'incendie qui sont placées à un écartement de 100 à 150 m. Les poteaux d'incendie sont à préférer aux bouches d'incendie enterrées, parce que ces dernières sont plus difficiles à trouver. En cas de pression insuffisante, il est nécessaire d'alimenter les prises d'incendie avec un château d'eau.

En ce qui concerne le réseau d'égouts on aura soin d'augmenter la section des conduites des branchements domestiques pour éviter les engorgements provoqués par insuffisance d'alimentation en eau. Quand il manque un point de déversement naturel il faut procéder au traitement des eaux d'égout, bien que les baraques seront abandonnées au bout de 5 ans.

L'éclairage sera assuré au moyen de phares.

MISE EN PLACE DES BARAQUES

Comme déjà dit à propos de la viabilité intérieure, les logements doivent être réunis en **flots, chacun comprenant de** 10 à 15 logements, légèrement surélevés sur la chaussée. Cette avisement favorise la variété de la distribution et les rangées monotones qui rappelleraient les camps de concentration. La surface des baraques doit être proportionnée à la composition de la famille, à savoir: cuisine, salle à manger, une chambre à coucher, W.C. de 35 m2 de surface; cuisine, salle à manger, deux chambres à coucher, W.C. 45 m2; cuisine, salle à manger, trois chambres à coucher de 60 m2 de surface.

En ce qui concerne les services collectifs on doit suivre les principes généraux d'un plan d'amenagement: il faut situer le centre de direction (Mairie, P.T.T., bureaux divers, station de police, dispensaire, église) près de l'agglomération plus importante; écoles maternelles et primaires près des agglomérations moyennes et les écoles secondaires près du centre de Direction.

Les ossatures préférables pour les baraques sont en fer avec panneaux-sandwich isolants; de toute façon, en cas d'extrême urgence, on est obligé d'employer les types qui se trouvent facilement dans le commerce, tandis que pour les commandes successives on pourra choisir le type plus indiqué au point de vue technique.

Les planchers des baraques doivent être surélevés au-dessus du sol, ou bien être posés sur un drainage en pierres pour assurer la protection contre l'humidité ascendante.

Le drainage en pierres est à préférer, parce que l'espace libre au-dessous du plancher est sujet à se remplir d'ordure et à attirer des hordes de rats.

L'étanchéité des toitures, des portes et des fenêtres doit être particulièrement soignée.

Il faut surtout mettre en évidence ce principe: les baraques doivent être projetées en parfait accord avec l'économie et les traditions locales, comme une architecture valide doit s'inspirer à l'ambiance environnante. A titre d'exemple, nous pouvons citer les villes détruites de "La Vallée du Bélice". Ces villes siciliennes étaient des agglomérations urbaines où vivait une population paysanne, habituée à garder, près de l'habitation, denrées alimentaires, semences et outillages. Cette circonstance a conseillé de construire des entrepôts collectifs pour les produits de l'agriculture et les outillages.

En soulignant l'importance des traditions locales nous pouvons conclure l'argument concernant le rétablissement des services essentiels pour la vie des sinistrés.

La troisième et dernière phase, c'est-à-dire la reconstruction à la charge de l'état, sera bien accueilli de la population si, au lieu d'être limitée au rétablissement des anciennes structures (urbaines, économiques, etc. etc.) elle s'adressera à établir les meilleurs conditions pour le développement économique et social.

CCMS No. 9

MODALITIES AND CRITERIA FOR RESTORATION OF PROPERTY DESTROYED BY EARTHQUAKES IN ITALY

METHODES ET CRITERES DE RESTAURATION DES BIENS DETRUITS PAR LES TREMBLEMENTS DE TERRE EN ITALIE

by Dr. G. Colluci

Information may be obtained from the address given below:

Des renseignements peuvent être obtenus à:

Organo centrale statale della programmazione
economica,
ROMA,
Italia.

BASIC CONCEPTS FOR THE FORMULATION OF A NATIONAL EMERGENCY LAW IN ITALY

I. Generalities and conceptual frame of its content and conception:

This law must contain the concepts of "National Defence" in the part concerning to the Internal Defence of the Territory, which according to experience has been subdivided in two areas:

- The defence against disasters and catastrophes (cause of the present law) for cases of national emergency.
- Civil defence for cases of national war and of emergency.
- Scope.
- Objectives and limitations.
- Declaration of national emergency; regional, zonal, area.
- Time and conditions.

II. Definitions

(a) Catastrophes and calamities.
(b) Kind of disasters.
(c) Tipifications of disasters and its location in the national territory.
(d) Periods of the disasters (basic studies and its development).
(e) Periods and time that takes a national disaster.
(f) Characteristics and consequences of each of the types of disasters.
(g) Damages caused by disasters estimated in each period.

III. Generalities of National Emergency Law

(a) Define the objective, scope and importance of the law and its considerations that point out the ends.
(b) Must be actioned by a permanent organism.
(c) Adequate structure of its organization only for the periods of emergency and temporal rehabilitation.
(d) Give power, full authority and one command and intrasferable responsibilities in taking decisions.
(e) Specify in clear terms the duties of execution and the component organisms during all the period that takes the catastrophe as well as the responsibilities of carrying out those duties.
(f) Its ubication to a very high level, as well as its relations of dependance and co-ordination, with organisms of the State.
(g) Wide freedom of action to take decisions, dispositions and orders, in a very short term.

IV. Responsibilities of the EEN

(a) In the preventive phase to the disaster.
(b) Just before the disaster is produced.
(c) During the different periods that comprise the catastrophe.
(d) Specify the functions of all and each of the components of the National Emergency Council.

V. Funds and its use

(a) In the emergency period.
(b) In the period of rehabilitation and basic reconstruction.
(c) In the period of permanent development.

VI. Classification and control of resources, during the following periods:

- Preventive phase
- Emergency
- Rehabilitation, reconstruction of Basic Emergency of Permanent Development (long, medium and short-term)

Sources:

National

- Through special laws
- Through donations
- Through own resources

Foreign

- Through donations
- Through loan
- Through acquisitions
- Through transference of equipments, personal and others
- Transference of technology (for the development).

VII. Responsibilities of the:

(a) Execution organisms (public sectors, other organisms)

1. During the preventive and safe period
2. During the emergency period
3. During the rehabilitation and basic reconstruction periods
4. During the period of permanent development

(b) Organisms of scientific and technical support

1. Preventive period
2. As soon as the emergency is produced
3. During and after each one of the periods that comprise the catastrophe
4. Co-ordination at the most high level with the National Research Council and research; institutes

(c) From the emergency committees:

- National

- Regional
  - Zonal
  - Area Province and District
  - Organization
  - Functions
  - Responsibilities

(d) Rules of the Emergency Committees

(e) Rules of the Civil Defence

- Objectives
- National Organization
- Functions of the Committee of Civil Defence.

URBAN RECONSTRUCTION PLANNING - THE ALASKA EXPERIENCE

by

Lydia Selkregg

(see/voir pages 17.1 to/à 17.10)

TERREMOTO DEL 31 DE MAYO DE 1970 - PERU

This 50 page report, written in Spanish, describes the circumstances of the Chimbote (Peru) earthquakes on 31st May, 1970, the measures taken to mitigate its effects, and the recommendation for further actions. Copies may be obtained from the address given below.

* * * *

Ce rapport de 50 pages, rédigé en espagnol, décrit les circonstances dans lesquelles s'est produit le tremblement de terre de Chimbote au Pérou le 31 mai 1970, les mesures prises pour en atténuer les effets et les recommendations quant aux actions à prendre pour l'avenir. Des copies du texte peuvent être obtenues à l'adresse ci-dessous.

Mayor General FAP Rolando Caro Constantini,
Presidente del Comite nacional de emergencia,
Palacio del Gobierno,
Lima,
PERU.

(See/voir page 18.1)

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Rehabilitation of Services and Installations in case of National Disasters

Restauration des services et des installation en cas de Desastre National

Col. H. Rozas Calderon

El territorio peruano de una sismicidad dominante y de características geológicas muy especiales por encontrarse en el extremo centro occidental de Sud América, en donde corre de Sur a Norte el gran espinazo de la Cordillera de los Andes y donde ya con la experiencia pasada y presente (última catástrofe de 1970) requiere acciones más definidas y convergentes para evitar que los desastres dejen como saldo negativo en su proceso de desarrollo todo el vigor inimaginable y que constituye uno de los factores de retrazo en la consecución de los objetivos nacionales, cual es el "Bienestar" y al alcance de mayores niveles de vida de sus habitantes.

Por lo expuesto una de las formas observadas para atenuar esta grave amenaza, tanto en su mar y territorio continental, se recomienda las siguientes conclusiones:

1º.- Se propone a este honorable Congreso de expertos de la creación de un Instituto Regional de Sismología y Ciencias Conexas, con el objeto de que sea factible la coordinación y sistematización de las observaciones para sacar conclusiones [illegible] que traten de encaminar los datos, hacia una utilización inmediata en la disminución de efectos de todos los tipos de catástrofes. Con este fin se requiere la implantación de una red de estaciones de observación geofísica y sísmica en los puntos claves, considerados dentro del territorio nacional que informarán debidamente del resultado de sus observaciones y evaluación de los mismos hacia la Central de Información que se encargue de la interpretación, desarrollo y difusión en provecho continental.

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2º.- Se establezca un sistema de comunicaciones de acción instantánea, en lazada a estas estaciones de observación capaz de alertar y dar el tiempo suficiente de poner en acción los planes de Emergencia al nivel Regional y luego Continental, empleando inclusive los sistema de satélites y el de los sensores remotos, a cargo de esta Central de Información situada en el Perú a cargo del Instituto Geofísico del Perú.

3º.- La creación de stocks permanentes de equipo y abastecimientos de emergencia en general, a cargo de "Organismos Internacionales" como la CRUZ ROJA y un sistema de transporte aéreo de gran capacidad a fin de que en el menor tiempo posible puedan llegar al lugar de su destino. Las apreciaciones cuantitativas y los planes pueden efectuarse en base a las necesidades habidas y la experiencia recogida del último desastre en el Perú. Ellos, en general son: Alimentos, equipo para salvataje, medicinas, material para alojamiento temporal y hospitales de emergencia, transporte de todo tipo.

4º.- La coordinación de las autoridades regionales en caso de desastres (nivel Estado) dentro de un plan continental de defensa contra desastres debe contemplar las siguientes fases:

- Fase de Emergencia de acción inmediata
- Fase de Rehabilitación y reconstrucción BASICA (a corto plazo) 1 a 5 años.
- Fase de Rehabilitación y desarrollo permanente que contemple proyectos de mediano y largo alcance preparados para períodos entre 5 y 20 años.

5º.- Se recomienda el empleo de las Tecnologías avanzadas en la búsqueda de la prevención de los desastre no solamente que éstas se traten de sismos sino de otros tinos tales como, huracanes, maremotos, sequía, inundaciones, etc.

CCMS No. 9

GERMAN FIELD - HOSPITAL OF THE ORDER OF MALTA IN THE EARTHQUAKE AREA OF PERU

(See/voir pages 1.1 to/à 1.6)

CCMS No. 9

The State of California passed extensive legislation for an emergency plan in 1970. This is called "California Emergency Services Act" Chapter 7 of Division 1 of Title 2 of the Government code (Stats 1970, ch 1454). Copes of the text may be obtained from:

The Director of the Office of Emergency Services,
Los Angeles,
California, U.S.A.

L'Etat de Californie à édicté en 1970 une législation complète sur un plan d'urgence appelée "California Emergency Services Act" Chapter 7 of division 1 of the Title 2 of the Government code (Stats 1970, ch 1454). Le texte peut en être obtenu à l'adresse ci-dessus :

CCMS No. 9

GROUP EMERGENCE IN COMMUNITY CRISES:

A STUDY OF THE CONDITIONS CONDUCIVE TO THE DEVELOPMENT OF COLLECTIVE BEHAVIOR

by

Arnold R. Parr
Department of Sociology
Disaster Research Center
The Ohio State University

ABSTRACT

Using data from five community crises, this study analyzes the conditions that facilitate the development of emergent groups in stress situations. We compare the empirical evidence from three community emergencies in which there was group emergence with empirical evidence from two community emergencies in which there was no group emergence. It is postulated that the conditions conducive to the generation of new groups in community disasters can be classified in a threefold typology: (1) social psychological conduciveness; (2) cultural conduciveness; and (3) structural conduciveness. We anticipate that the findings of this research will expand and extend collective behavior theory through devoting attention to the origins of collective behavior, an area which has received little prior emphasis.

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OPERATIONAL PROBLEMS OF ORGANIZATIONS IN DISASTERS

by E.L. Quarantelli and R.R. Dynes

The comments that follow are primarily based on field studies of about 45 different community emergencies conducted by the Disaster Research Center at Ohio State University. This research has examined many different facets of organizational responses in extreme stress situations. However, we shall report here only on certain operational problems of organizations in disasters.

In the Emergency Operations Symposium last year we set forth a fourfold typology of group behavior in community stress situations.[1] Since the bulk of this paper uses this typology, it would probably be best if we briefly restated it here again. The typology is derived from a cross classification of two important variables -- one, the nature of the disaster tasks undertaken by the groups; and two, the emergency period structure of these groups.

In any emergency, a group's tasks may be old, routine, or everyday ones. Or instead of regular, the tasks may be new, novel, or unusual ones for the groups involved. If a police department controls traffic, a fire department fights fires, or a hospital treats the injured, these are regular or traditional tasks for such groups. On the other hand, the irregular or newly created nature of tasks can be seen in crises where an army battalion has the responsibility of providing water for a community, a VFW post shelters evacuees, or Catholic nuns sort and distribute clothing from a relief center. Thus, it is possible initially to divide organizations and groups into those having regular or irregular tasks.

It is also possible to distinguish between groups with an old or existing structure and those with a new or crisis-developed structure. The former kind of group is one in which the members stand in definite predisaster social relationships to one another, especially in their work activities. Such groups exist as an entity prior to the disaster event. In such groups during a disaster, the members continue in somewhat the same work relationships as they had prior to the emergency. Thus, the members of a metropolitan public health department or a ham radio club activated in a disaster normally have had work relationships prior to the stress situation. Such social ties, then, are maintained as the group engages in either traditional or irregular tasks during the emergency.

On the other hand, new group structure may come into being during the emergency. Such groups may either mushroom from a small predisaster core or they may involve the crystallization of some totally new entity. The crucial feature is that such groups have no actual preemergency existence, at least in the form that they take during the emergency. An example would be a local Red Cross chapter whose handful of full-time, paid personnel provides the nucleus for volunteers who undertake most of the expanded group's work. An example of an emergent group would be the search and rescue teams that develop in the immediate postdisaster emergency period. The new social entities may be partly planned, or they may be totally spontaneous, but the *actual* group comes into being only during the emergency period. The particular types of group behavior that appear in the immediate postdisaster period are depicted on the next page.

There are certain dimensions of the crisis situation that affect the operation of these organizations and groups. Going back to one of the variables used in the initial classification (the difference between groups that had a preexisting structure and those that developed a new structure), attention is given here to the implications of this difference for operations in the emergency period. For those groups with an existing structure, particularly Type I organizations, the basic problem can be seen as adapting the functioning of the ongoing organization to radically changed environmental conditions. In other words, the disaster event and its consequences create a "completely" different context for organizational activity, a context that makes the perpetuation of patterns developed from previous predisaster experience somewhat problematic. For those organizations with a new structure, particularly Type II, the basic problem is a radical change within the dimensions of the organization itself. In Type II organizations the expansion of the nucleus or cadre with regular and emergency volunteers in effect creates a "new" organization, so that previous patterns developed among the cadre have little meaning for their disaster functioning.

		TASKS	
		Regular	Irregular
STRUCTURE	Old	Type I (Established)	Type III (Extending)
	New	Type II (Expanding)	Type IV (Emergent)

ORGANIZATIONS WITH ESTABLISHED STRUCTURE

For those organizations that have a predisaster existence, it is important here to see that the disaster event itself creates a radically different context for organizational activity. The disaster event in most instances will create a sharp increase in demands made on such organizations, but it also creates conditions that produce a drastically changed external environment in which these demands must be met. To understand this new context, let us discuss initially five dimensions that are "new" as a result of the disaster event. These are as follows:

1. Immediately after impact, organizations have to operate under conditions of great uncertainty. They cannot automatically react to increased demands since they have no real knowledge of them. Uncertainty is a constant in every organizational environment. However, a disaster event initially provides only a tentative suggestion as to the scope of its impact. Thus an organization has little knowledge as to the magnitude of its future tasks. In addition to the uncertainty of the nature of the demands, organizations may also experience uncertainty as to the status of their own personnel and material resources as well as the status of other organizations on which they depend.

2. Organizations have to operate under conditions of urgency. As a result of the uncertainty and the probable increase in the tasks for the organization to accomplish, tasks which nominally could have been scheduled, routinized and delayed have to be reevaluated. Routines that develop out of the predisaster organizational experience may now become unnecessary luxuries. For example, the procedures for making decisions in an organization may be found unworkable since they are predicated on the presence of and the consultation among specific organizational members. Such optimum conditions for decision making after impact seldom occur but the frequency of making decisions increases. Many predisaster patterns, thus, of necessity are eliminated, abrogated or ignored in emergency activity.

3. Organizations have to operate in the context of the emergency consensus. In the new context, tasks that have previously been an integral part of organizational effort are eliminated for the "duration" and other tasks become the central focus. Most community organizations have multiple functions. They are engaged in many different types of tasks in order to achieve diverse ends. Some functions become extremely relevant after disaster; others become irrelevant. For example, handling traffic offenses may be an integral part of the predisaster activity of police departments but such activity almost always is suspended during the emergency period. It becomes relevant only when such offenses impede the restoration and maintenance of essential community services. This means, then, in such situations that personnel whose normal duties concern these functions have to be "withdrawn" since their activities do not "fit" the priorities of the emergency consensus. These personnel, then, become engaged in activities with a higher priority but such activities have only limited continuity to the particular predisaster activity of such personnel. Certain organizations cease functioning entirely during the emergency period since they do not have relevant tasks in terms of the emergency consensus. The same is true of certain subunits of organizations. Just as those organizations for which community expectations do not exist for their involvement may seek to become involved (e.g., Type III groups), subunits of Type I organizations may be "without" their traditional functions and predisaster activities. Shifting these personnel to new tasks necessary in terms of the new consensus may radically change the predisaster patterns within the organization.

4. Organizations lose autonomy in disaster conditions. In predisaster conditions, organizations have differing degrees of autonomy, i.e., an ability to control the organizational environment so that significant activities can be internally determined. In a disaster, organizations have to operate in a larger community context in which established relationships have to be reworked since they cannot be assumed. The same loss of autonomy is evidenced in the subparts of the organization. The detective bureau of a police department which previous to the disaster had a great deal of autonomy "comes back" into the organization in the sense that the predisaster understandings which give the bureau a degree of independence are no longer extant.

5. The basis for participation within organizations is changed in disaster conditions. Etzioni has suggested that the reasons why individuals follow organizational directives can be explained on the basis of three types of compliance.[2] The first type is based on compliance as a result of coercion. Individuals who are participants in prisons and custodial mental hospitals would illustrate this. The second type of compliance is utilitarian in which the

person participates because he is remunerated. Most workers operate on this basis when people are paid for their efforts. The third basis is normative, in which participation is a result of the belief that the demands made by the organization are legitimate. This type of compliance is found in religious organizations, universities, voluntary associations as well as certain political organizations. For most of the Type I and III organizations, compliance prior to the disaster in general is utilitarian but, under disaster conditions, the basis of compliance shifts toward the normative. In other words, the members of organizations participate on the basis of accepting the directives of the organization as being legitimate. Questions of whether they "have" to do something, or whether they will get paid for doing something are irrelevant, and the involvement of personnel is cast in terms of the necessity of their participation in accomplishing certain tasks.

These five dimensions represent radical shifts in the environmental context for the functioning of organizations during the emergency period. Taking these dimensions and their implications, it is possible then to look at organizations attempting to cope with increased demands in the context of uncertainty, urgency, a "new" emergency consensus, loss of autonomy and a changed basis of compliance. The specific implications can be only briefly suggested here. Every organization develops certain patterned ways of carrying out its tasks. To carry out these tasks, ways of communicating within the organization are developed as well as describable patterns of authority and decision making. It is also useful to think of an organization as complex, consisting of several units. Some of these units may be more affected than others in the disaster involvement of the organization.

In general, a disaster event will have the following consequences for groups with an established structure. Certain aspects of its previous activities will become less important in its disaster functioning. For example, the routines which it has previously developed to accomplish its tasks will be disrupted. Traditional lines of communication and authority will be abrogated. Decision making will involve different processes and people than previously. On the other hand, there will be a significant increase in activities which are related to communication and coordination. There will be greater concern for defining the boundaries of the organization. Certain segments of the organization will become more crucial to the functioning of the organization than they were in predisaster functioning. It is useful to treat such consequences in terms of the dimensions of the "new situation" which the disaster creates. While they will be treated here abstractly and in isolation, in most instances, several, not just one, of these factors would be involved in effecting change.

UNCERTAINTY

In its predisaster activity, an organization develops over time certain characteristic ways of achieving its tasks. In general, community service organizations have more diffuse organizational goals than do production organizations. When a disaster event occurs, the goals of the organization tend to be relatively vague, either because these are implied and seldom actualized or because it is difficult in the uncertainty which is created how predisaster activity can be accomplished. (In certain organizations, such as businesses, uncertainty may create doubt whether the organization can continue in such a drastically altered context.) However, most community service organizations are expected to act in some fashion. Organizational members have accepted the notion that the organization should be involved and this is reinforced by the expectations of other community members.

Uncertainty works in two directions. First, it provides the conditions whereby an organization becomes involved. Second, it provides the impetus for certain shifts in the predisaster patterns of the organization. In addition to the diffuse "obligations" of the organization to become involved in disaster-related activity, uncertainty produces psychological strain on organization members. In order to overcome this strain, one common response is to "do" something. With such motivations, organization members often commit themselves to activities which have little relation to their predisaster activities or to the role which the organization has defined for itself in disaster. Individual commitment to particular activities as a defense for uncertainty then often leads to organizational commitment. If an individual becomes involved, he then may request help from other organization members and from the resources of the organization. Such requests then provide other organization members with "something" to "do" since they feel the same urgency to act. In addition, the involvement of individuals in specific disaster tasks often fosters organizational involvement. Since the individual is a "member" of the organization, there are certain obligations toward him, and the resources of the organization, not committed, may be diverted into "his" activities. Once committed to a particular line of activity in such a way, an organization may find it difficult to divest itself of the "responsibility" and to concentrate its resources in other directions. Also, such involvement tends to preempt this sphere of disaster activity so that other organizations move in the direction of different "unmet" community needs.

Uncertainty leads to involvement of organizations in another way. The existing organizations have readily available personnel who possess organizational "loyalty" and can be mobilized quickly and effectively. These resources are ready and waiting, but only the organization has knowledge of its task which is based on the reports that they initially receive. If they wait for a clarification of the situation so their role and tasks can be clearly defined, they run the risk of being defined by others as "not" willing to help. This leads to a rather quick commitment of personnel and resources to tasks which are often "outside" the scope of their predisaster experience or their anticipated disaster role.

Uncertainty also has implications for the internal structure of the organization. Certain segments of the organization become more crucial than others, and certain processes of the organization receive more emphasis and effort. In general, one might suggest that the operational elements of the organization increase in their importance while those segments which deal with organizational maintenance and administration recede in their importance. This, in turn, affects the relative status of individuals within the organization. Operational personnel become more important in the total operation of the organization. More specifically, uncertainty demands that greater organizational activity initially has to be given to gathering information. Certain personnel will have to become involved in gathering information about the changed environment and of the operational capabilities of the organization. This need for "knowing" often means that predisaster lines of communication can no longer be followed and new lines, emergent in terms of the specific tasks which have been accepted by the organization, have to be developed. They are not developed by design but by expediency.

The authority patterns and the usual decision making processes tend to be "replaced" by new ones. Because of the impact of the disaster and the difficulties of mobilization for particular individuals, certain personnel involved in decision making may be absent. In addition, the new problems which are faced by the organization may demand a different type of expertise and a different pattern of consultation than the predisaster problems.

In the early emergency phases when the implications of the disaster are uncertain, there is also a tendency to add personnel, either in the sense of "over" mobilizing the organization, i.e., calling in all shifts, or by "stockpiling" volunteers who may be useful in activities which the organization might find itself at some later time. The addition of such personnel in itself changes the structure of the organization and the patterns of its predisaster activity. Such "excess" personnel affects certain segments of the organization more than others, but in any case, the presence of added personnel as insurance against the unknowns of the environment in many ways creates a "new" organization.

URGENCY

In addition to the uncertainty of the situation, organization members feel some urgency to accomplish those tasks which are as yet still undefined. This urgency is translated into a greater autonomy on the part of individuals throughout the organization. Individuals take the initiative for actions which, according to predisaster patterns, would require and result in extensive consultation with others. Decision making is short-circuited, not involving those who "should" be consulted but those who happen to be available. Decisions made in this way are often later given sanction in an "ex post facto" fashion. In other words, members of an organization experience an increase in autonomy. They initiate actions which they normally would not without extensive consultation. This autonomy of action is subsequently supported by those in authority as being appropriate for the occasion.

Urgency also affects certain segments of the organization more than others. Because certain segments of the organization become less important, such as administrative and other segments devoted to organizational maintenance, those individuals who have predisaster responsibility involving such tasks will have greater problems in determining their own activities. Stated in another way, the more a segment of an organization deals with routine maintenance tasks or administrative tasks, the more problems it will have in mobilization and in functioning during the disaster operation.

EMERGENCY CONSENSUS

One of the major reasons for shifts in the importance of particular segments of an organization is that such shifts are "demanded" by the emergency consensus which emerges. Certain tasks normally performed by an organization become irrelevant in this new context. For example, formal admittance procedures in a hospital may be ignored except as they relate to crucial medical information.

In certain ways, this tendency may increase the efficiency and effectiveness of an organization since those aspects of the behavior within an organization which are irrelevant tend to be dropped and efforts then center on accomplishing the immediately relevant tasks.

The emergent norms from the community consensus also tend to override norms specific to the organization which would conflict with them. For example, norms specifying appropriate dress patterns for work are neither enforced nor considered relevant. In general, status distinctions which may have been exceedingly important in the activities of the organization prior to the disaster are relaxed and equalitarian relationships become normative. Scarce goods and symbols which might have been the object of competition become common property. Offices which were sacrosanct now become communal property and organizational resources which were carefully conserved become available for use.

While the overall effect of the emergency consensus is to level status within the organization, the importance of certain tasks within this consensus tends to enhance the status of certain segments of the organization. For example, operational groups within an organization often have lower status than do certain administrative personnel. The disaster event tends to increase their worth and such segments temporarily achieve higher status and priority in the organization as compared to other groups and as compared to normal times.

Since there are shifts in the "importance" of different segments of an organization, this tends to modify the existing patterns of coordination among the various departments. A segment which traditionally issues requests to another part of the organization finds itself now becoming an "errand" boy. The same phenomenon is observed in coordination among organizations. Particular organizations which have not been essential in the ongoing community process are found to be critical and crucial during the disaster experience. For example, while normal community coordination may involve informal contacts among specific organizations, groups with a specific coordinating function such as civil government or civil defense may be almost ignored prior to a disaster but become exceedingly important during a disaster. Prior planning for disaster activities often ignores the importance of certain organizations during disaster operation, but judges them from their significance in predisaster relationships. In effect, it is suggested here that the status of an organization or a particular segment of an organization is determined by the closeness of fit between its disaster-related activities and the emergency consensus which develops within the community. Shifting status creates, for many organizations, a new operating context. Some lose, others gain status during the emergency period. Within an organization, certain segments become more important than others and reflect a pattern quite different from their predisaster relationships. This means that patterns of coordination planned for and actually used among organizations and within specific organizations then become disrupted.

LOST AUTONOMY

The norms of the emergency consensus come into prominence during the emergency period and override the more "private" norms of the particular organization. There is also pressure for any particular organization to show that it is properly concerned with the total needs of the community. By placing itself at the service of the community, an organization then opens itself to receive direction from, or at least having to react to, influences outside the organization. Such influences may vary from specific requests from the city government to reacting to the activities of other organizations. All of this implies a loss of organizational autonomy.

In addition, many organizations which have to coordinate their activity with state, regional or national hierarchy may find themselves called upon to inform such levels more frequently of their activity, thereby reducing their autonomy. More likely, such higher levels of the organization may send personnel to help the local group. The presence of extra-community personnel on the local scene means that activity comes under their scrutiny and perhaps adds another level of consultations in decision making. For example, the local telephone company may request additional help or additional help may be sent without such a request. Such help often involves individuals whose normal position in the larger company is superior to any of the local personnel. The presence of such personnel often evokes changes in the traditional ways of doing things.

Within the organization, greater effort and energy must be spent on activities dealing with coordination. In addition, because of the greater permeability of the organization, it becomes more difficult to define clearly the boundaries of the organization -- in particular, what members can act in the name of the organization? Since individual members have greater personal autonomy, these members may commit the organization to activities without the advice and consent of the traditional decision makers.

CHANGED BASIS OF COMPLIANCE

It was suggested earlier that the basis of compliance shifts from a utilitarian to a normative orientation during the emergency period. This has several implications. Since the individual becomes "totally" involved with the activity of the organization, the organization of necessity becomes totally involved with him. In other words, concern for the total well-being of the worker is manifest as compared with a rather narrow concern during predisaster operation. Perhaps the best illustration of this would be in the instance where the family of the worker is put under the auspices of the organization for protection. This may involve responsibility for shelter and evacuation during preimpact periods. It may involve care for family members whose living arrangements have been destroyed or damaged by the impact of the disaster. Such concern and care for family members does, however, tend to divert organizational resources toward specific individuals to which the organization "feels" an obligation. In turn, such resources cannot be used in more diffuse community activities.

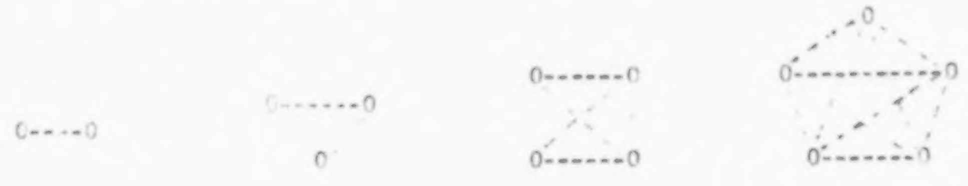
In instances where the organization assumes responsibility for family members, such "benevolence" is often repaid in kind by the family members who volunteer their services and work within the organization. These "family" volunteers then create for the organization the problem of all volunteers. In particular, it necessitates diversion of attention of regular organization members to supervision and instruction of the new personnel. The consequences of this will be seen more clearly in the discussion of the expanding organizations.

ORGANIZATIONS AND GROUPS WITH AN EXPANDING STRUCTURE

As we suggested earlier, Type II organizations have a latent emergency function quite apart from their normal day-to-day activities. It is expected that these groups will become active in a different way during the emergency period. Such groups provide the name, a location and a cadre of permanent workers which serve as the basis for operations in a disaster. While such groups become involved in a variety of tasks, the common characteristic among such organizations which will be emphasized here is the expansion of personnel necessary to operate in the disaster context. While this expansion is "planned" in the sense that it is anticipated, let us suggest here that the basic operational problem for such groups is the unanticipated organizational change which occurs with this increase in personnel. A related problem stems from the kinds of changes which are made. Regular personnel move into new and unfamiliar positions within the expanding organization. Other positions are filled with volunteers who have varying degrees of skill and previous connection with the organization. The entire personnel then are occupying "new" positions and are involved in unfamiliar social relationships.

While many organizations grow in nondisaster settings, adaptations to the consequences of growth tend to be gradual. Specific problem areas become apparent and the adaptations necessary are made over time. Most of the organizations expected to "grow" during disaster operations consider such growth as a necessary condition for the accomplishment of anticipated tasks and have little awareness of the consequences of such expansion for the actual operation of the organization in the emergency period.

Initially, let us discuss some of the sociological consequences of an increase in size of an organization and then look at these consequences in the context of disaster operation.[3] Possibly the most important effect of increasing size is on the pattern of interaction among the parts of an organization. Stated more formally, as the "membership" of an organization increases arithmetically, the number of possible channels of interaction increase geometrically. The increase in communication channels is portrayed below. This is based on the sum of all possible combinations -- pairs, triples, etc. Also one is added for the possibility of simultaneous interaction of all parts.



2 persons - 1 relationship

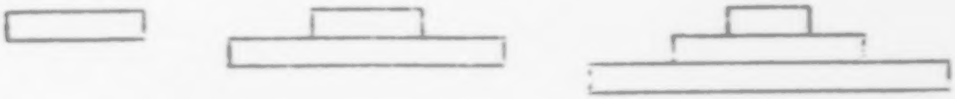
3 persons - 4 relationships

4 persons - 11 relationships

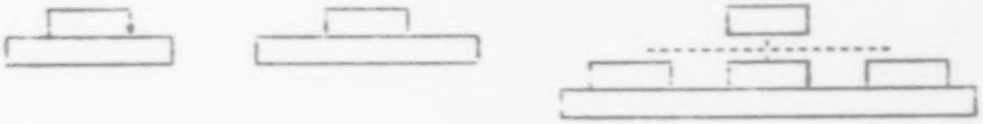
5 persons - 26 relationships

With an increase in size, parts of the organization are differentiated -- certain parts do one thing and certain parts do others. In order to coordinate these diversified activities, the parts become arranged into layers of authority.

Thus, with an increase in size, there is a tendency to increase the number of levels of authority. This increase in the levels of authority could be portrayed as follows:



In addition, with increasing size, there is a tendency for the ranking systems upon which authority is based to increase. For example, in a small community, a mayor and a small number of personnel under him may "operate" the community. But as a community increases in size, a number of specialists are necessary to become involved in the engineering, financial, tax, personnel, etc., problems of this city. While the mayor may still "give orders," such specialists still have a considerable influence over the affairs of the city by virtue of their skill and knowledge in these more specialized but necessary areas. This increase in ranking systems can be portrayed like this:



While these are only three of the consequences of increase in size, these and others have important ramifications for the operations of an organization which expands. When expansion occurs over a period of time, adaptations are made gradually. With the increase in the channels of communication, certain ways of communicating become considered appropriate and others inappropriate. In other words, certain norms are developed to specify the appropriate channels of communication. These tend to become formalized which, in turn, leads to the characteristic formality of large organizations. Too, the coordination necessary for the proliferating parts of the organization is developed. Certain positions are designated with the responsibility for coordination. In part, this is done by giving certain positions control over other parts of the organization by the power to allocate resources differentially. Over time, the rights and responsibilities become institutionalized into an authority hierarchy. This implies that authority exists in an organization when others in the organization accept the rights and responsibilities of particular positions as being legitimate. Within the same developing authority structure, accommodation is made for the increase in the types of authority. In more familiar industrial terms, some accommodation is made to the line and staff problems of authority. While it would be overstating the case to suggest that outside the disaster context, organizations which experience growth "solve" such problems, it is appropriate to suggest that they do develop institutionalized ways of handling them. In most instances this is done by developing rules and more formalized specification of duties and responsibility which become an integral part of the day-to-day operations of the organization. Sudden expansion does not allow time to develop such institutionalized patterns. Nor are these patterns anticipated in the predisaster planning. Expansion is planned in terms of allocation of tasks with the prime consideration given to more personnel to handle the increasing demands made by the disaster event. The achievement of disaster-created tasks, however, cannot be handled by the simple addition of personnel. Let us look at some of the more specific consequences of these expanding organizations.

1. Accomplishment of Tasks. While earlier we characterized Type II organizations as those who were involved in regular tasks, this was intended to imply that such organizations had latent disaster activities. These activities, however, are not necessarily identical or even similar to the day-to-day responsibilities of organization members. In the first place, in their organizational charter, many of these groups are expected to "assist," "help," "be responsible for" certain disaster-related activities. Both the extent and the limits of these responsibilities are often unclear. For example, if an organization is "supposed to care for survivors," does this mean to supply the basic necessities or does it extend to collecting information about the survivors and to providing such information to others? In this specific instance, it is common for several expanding organizations to begin to collect such information, thus duplicating the activities of the others. In communities without the experience accumulated by repetitive events "the helping" have few limits. Organizations know they are responsible to do something but they are not sure of what is included in the "something." In this sense, the anticipated activities of the organization may not be particularly helpful to clarify their actual role.

Too, since the core members of the organization are reassigned to new positions within the expanding structure, the allocation of persons does not mean that they necessarily understand their new roles or are capable of operating effectively in them. For example, an individual whose previous position within the organization might have been at the operations level may find himself assigned to a position coordinating an influx of volunteers. Even if he clearly understood these sudden responsibilities, this is still no assurance that he would be effective in such a position. One might suggest that certain individuals may find it difficult to shift so quickly and, in fact, the person's experience over time in assuming his traditional responsibilities might develop a "trained incapacity" to fulfill new ones. This ability to function effectively might also be inhibited if those who have low status within the organization find that their new position involves supervision of persons who hold a much higher status within the community. This problem can be important at different status levels within an organization. Form and Nosow suggest that "professionals in organizations using volunteers often find themselves directing volunteers who have higher status in the community."[4]

Plans of expansion, then, usually involve moving regular organizational personnel in new positions with new responsibilities for tasks which may be anticipated but also may be vague. When the plan for expansion is operationalized, regular personnel occupy new roles with unfamiliar and unclear responsibilities and work with others with whom they have had little or no previous contact.

2. Communication. As we suggested earlier, an increase in the size increases the channels of communication geometrically. In normal expansion, this problem is usually handled by the specification of appropriate channels of communication. Such appropriate channels are normally specified formally and the actual means

of communication may also be specified. For example, a work group is supposed to report verbally to their supervisor; the supervisor is supposed to report by memo to someone else, etc. In addition, channels of communication often develop informally. The prescribed ways may be replaced or supplemented by widely understood but informal means. In expanding organizations, the formal specification of appropriate channels of communication may be made in "planning" but following them requires both knowledge and experience and the expanding organization has neither. Too, no informal means have developed, since the group has not worked together previously. So, an expanding organization has no channels of communication meaningfully specified either at the formal or informal levels. This means that appropriate intermediate filtering which "protects" those in top positions from being flooded with information is not present.

Openness of communication is also facilitated by the disaster context. The leveling of status tends to open up communications channels which normally would be closed by status inhibitions. A lower level employee whose normal position within the organization would inhibit his approach to "top" personnel now feels a degree of comraderie with them on the basis of their continuity of experience within the organization. Too, the loss of status symbols, the shifting of personnel to new positions and the influx of new personnel all contribute to a fluid status structure within the organization which accentuates the flow of information along the increased channels of communication.

3. Authority. It was suggested earlier that an increase in size is related to an increase in the levels of authority, necessitated in part by the need for control of the newly developed subparts. It can be suggested that, in a disaster context, while more authority levels are "needed" with expansion, they do not develop easily. In part, they do not develop since prior planning of the expansion usually is concerned with task allocation rather than the coordinative functions necessary for tasks. The development of authority within an expanding organization is complicated additionally by three other factors. First, there is the intrusion of influence from the community which is irrelevant or even antagonistic to the emergent authority structure of the organization. Many expanding organizations anticipate their needs for new personnel and recruit on a standby basis those who have emergency-relevant skills. Depending on the nature of the organization, such personnel may possess technical, administrative, medical, public relations, engineering and other skills. While some of the activities these personnel will engage in are related to their predisaster training, their presence within the organization multiplies the types of influence which exist within the organization. This applied even when the person who possesses such influence is not functioning in a position which utilizes his particular skills. For example, a physician who finds himself in an administrative position may come to have greater influence in the direction of organizational activities than his actual position within the expanded organization dictates. This may not be due to any overt act on his part but, in his organizational performance, he will be evaluated by others, not in terms of his new organizational position but in terms of his more general community status. In the absence of knowledge about the authority of a new position, the more general status of the person will be accepted as a basis of authority. This tends to diffuse the authority structure.

A second problem of authority is related to the first. Many expanding organizations in most American communities have connections with other segments of their organization on the state, regional and national levels. As a part of predisaster planning, various personnel from other segments of the larger organizations may be dispatched to the local group as a part of their expansion. In the preplanning, such personnel are seen as supplementary and often are supposed to assume positions that are lower in authority than the local person in charge. In other words, they submit themselves to the local authority and do not attempt to impose external authority. However, such personnel, in predisaster and also in postdisaster situations, may hold positions in the larger organization that have higher authority than any member of the local cadre.

For example, a state director may temporarily become a "member" of a local organization and "submit" to local authority. Even though many of the new personnel would not know nor understand his predisaster position the permanent cadre would be aware of it and would, in most instances, react to him in terms of the predisaster pattern of authority relationships. The very presence of such a person would necessitate his involvement in crucial decisions and may, in many instances, inhibit the assumption of authority by other permanent cadre members.

A third problem relates to the institutionalization of authority. Influence does not become authority until others accept the legitimacy of the demands that those in particular positions can make. In other words, the establishment of a new position does not automatically establish a new level of authority. When individuals within an organization accept the notion that the person within the position has the right to "order" certain things done, then authority is established. These conditions are seldom met in an expanding organization because time does not allow this. The lack of experience of working together as a functioning group prior to the disaster event also creates the conditions whereby the authority of the preexisting positions tends to be carried over, either by those within the cadre or by those from other levels of the organization. Those local volunteers who are added for expansion do not have the experience and knowledge of the previous organization so they do not know the previous model of authority. As we have suggested, certain of the volunteers will bring disaster-relevant skills and, in the absence of a clear authority, their personal influence will often be accepted as a basis for authority which may have little relation to the "needs" for authority within the organization.

The status-leveling consequences of this disaster event also have implications for authority patterns. "Normal" status symbols disappear in the disaster context and the "loss" of these inhibit the development and institutionalization of authority necessary for the expanded organization. The problems of authority, then, reside in the "necessity" for more levels to develop within an expanding organization. The institutionalization of authority, however, takes time to develop. In the absence of institutionalization and in the status-leveling context of the emergency period, the preexisting patterns of authority tend to be carried over. These patterns, however, are complicated by the addition of personal influence brought into the organization by various types of volunteers and by the lack of familiarity among those which become involved in the organization. The resulting pattern of authority relationships will seldom follow the preplanning for expansion of the volunteers nor will it necessarily be functional to the tasks created by the disaster agent.

4. Decision Making. In the predisaster functioning of an expanding organization, certain patterns of decision making exist. These may follow the patterns of responsibility and consultation expressed in the formal organization or informal patterns may have developed with experience over time. Since both the formal structure and the informal relationships change with expansion, such traditional patterns become less appropriate. With expansion, such traditional patterns become less understood among organizational members, particularly the "volunteers." Even the permanent cadre now are shifted into new relationships so they are uncertain of applicability of the predisaster patterns.

In the disaster context, there is an increase in the number and importance of the decisions that have to be made within the organization. The increased necessity for making decisions is further complicated by other factors. Information relevant to the decision-making process comes into the organization from a greater number of different points and from a wider variety of sources than is usual. Information received that makes demands on the organization may be suspect in the sense that it comes from "unknown" or at least "unfamiliar" sources. The nature of the information may also have an unbelievable character since it refers to tasks necessitated by the disaster event. Too, the fact that such information is received by "unknown" members of the organization tends to compound the evaluation process. The openness of communication tends to distort the information since it is channeled through many people.

As a result of these factors, it can be suggested that decision making tends to develop a greater degree of autonomy. That is, decisions have to be made, but the information necessary and the consultative pattern that is normative is not known by those confronted with the necessity for an immediate decision. Given such circumstances, the tendency is to make decisions on the spot for those who are immediately confronted with the necessity for making the decision. Such decisions often commit organizational energies without clear knowledge of organizational resources. Decision making, then, becomes more situational and decisions are made responding to immediate demands by those who have organizational identity but little organizational responsibility. All of this tends to diffuse the decision-making process and results in a lack of coordination among the subparts.

5. Delineation of Organizational Boundaries. A major problem for an expanding organization is the determination of the organizational boundaries. In most established organizations, "membership" in the organization is clear. People occupy particular positions within the formal structure and, by virtue of these positions, are able to act in specified ways for the organization. If their actions go beyond the authorization of the organization, there are disciplinary actions available. Expanding organizations, however, have little idea of their boundaries. Volunteers have little idea of their responsibilities and organizations have few mechanisms of social control available to "discipline" their personnel.

Organizational identification on the part of most volunteers is minimal. Their recruitment may be the result of a long-standing connection with the organization but it is often the result of circumstances whereby the person "walks in" and suddenly becomes a member. These volunteers have greater difficulty being integrated into the organization. Form and Nosow suggest on the basis of the Flint-Beecher tornado that "individuals with poorly defined or undefined roles had to improvise so they lost valuable time developing rational responses to the demands of the situation."[5]

In fact, they go on to suggest that, "The help offered by volunteers may be more detrimental than helpful if not properly organized and channeled: it may a) 'overload' existing organizations; b) result in frustration for the volunteers since they are defined as unnecessary outsiders when they cannot find a functional position in the disaster system."[6] The motive of the volunteer is "to help." With unclear roles often offered him, it is difficult for him to develop any organizational identification. Because he is assumed by others to have organizational responsibility, he often makes decisions which commit organizational resources. In other words, he is a member of an organization but does not know his rights and responsibilities.

The organization, on the other hand, is confronted with an increased number of personnel but has few means of controlling them. There are few "personnel" policies which govern these workers. The functioning of the organization has to depend, in large part, on the willingness of these workers to continue. Since the availability of such personnel is flexible and may vary tremendously over the emergency period, the development of a rational plan which attempts to maximize energy and minimize fatigue is difficult. Since the activities of many of these volunteers are beyond the scope of observation of the regular members, the ability to define rights and obligations of particular positions is minimal. To do this systematically takes time away from disaster-relevant tasks and would require the time and energy of permanent personnel needed in other tasks.

The result of this is that individuals act in the name of an organization and commit organizational resources, given the conditions of autonomy in decision making in expanding organizations. To clarify organizational procedure and to define responsibility would take the time of crucial personnel and would risk alienating the motivated volunteer. The result, however, is that many persons act in the name of the organization with little knowledge of scope and limits of the responsibility and of the procedures which are normative to accomplish the tasks.

A FINAL NOTE OF PROBLEMS OF ORGANIZED ACTIVITY

While we have been discussing the problems of each of the four types of organizations and groups separately in order to simplify and sharpen the contrasts among them, this should not obscure the fact that the problems which confront specific types of organizations can also be experienced by different parts of the same established organization. Parts of an organization may be differentially affected by operations in the disaster situation. While its preexisting structure is "brought" into disaster operations, this structure actually may be modified in the organization's activities during the emergency period. Since organizations are characterized by complexity, this means that they have subparts. These subparts, then, may show different responses to the requirements of the disaster event. The direction of adaptation of the subparts tends to follow the pattern of the emergence of the four types of groups. Some subparts of the organization may operate in the disaster context with old tasks and with a structure which is relatively unchanged (Type I). Other sections of the organization may be expanded by the addition of new personnel to cope with the overload of demands made on the organization (Type II). Part of the "addition" of new personnel may come from within the organization in the sense that the predisaster tasks of particular subparts now may no longer be meaningful and the personnel from these subparts can be utilized in performing "new" tasks (Type III). Because of the changes within the internal structure of the organization, accentuated by the rearrangements of shifts and the possible loss of key personnel, decision making may be relegated to a new "emergent" group within the organization (Type IV).

Illustrating this process, one might look at the operation of a municipal police department under disaster conditions. The communications section may be more likely to continue its predisaster tasks with the same personnel. These personnel possess somewhat specialized skills not easy to reproduce. There are also physical limitations of space and equipment which make expansion difficult. This part of the organization, then, continues operation during the emergency period following the patterns they have developed, working together prior to the disaster event. The patrol division, however, is expanded by the addition of a number of volunteers who assist the regular members in search and rescue, traffic control and security. Each patrolman may now have ten men "under" him and the officer in charge of the shift is now operating with a segment of the organization which is ten times larger than it was in its predisaster operation. The detective bureau may "suspend" its operation during disaster activity and its personnel, perhaps as a unit, are reassigned to new tasks. While this bureau has a predisaster existence, now it becomes engaged in "new" tasks. Because of such shifts within the organization, the predisaster patterns of decision making no longer are meaningful and a new group of decision makers, perhaps some of whom hold positions without such authority in their predisaster activities, now become involved in this process. In effect, then, the suggestion is made here that subparts of an organization may be affected in similar ways as the elaboration and changes which occur when one views the total organized behavior within a community. Certain groups (or subparts of existing groups) may continue traditional tasks but other groups or subparts may expand, become involved with new tasks and even "emerge" to cope with particular problems within the scope of their disaster activity. To the extent that the subparts are modified, they will evidence effects similar to those experienced by "total" organizations in the same situation of expansion.

INTERORGANIZATIONAL RELATIONS IN COMMUNITIES UNDER STRESS

by

Russell R. Dynes
E.L. Quarantelli

Organizations are affected by an emergency in different ways. Some suspend operations, releasing their personnel and other resources for the use of disaster organizations. Others remain active but convert to emergency work. Some established organizations, such as the police and hospitals, continue tasks that are part of their normal pre-disaster responsibilities. Others, notably the Red Cross and Civil Defense, are prepared to deal with emergencies but must rapidly expand their staffs and resources to do so. Finally, some entirely new organizations are brought into being by the emergency.

Relations between organizations in the emergency environment are affected by a number of factors, four of which are considered. The first is the legitimacy of each organization's involvement in emergency activities. The second is the existence of established personal contacts between organizations. Third are the bonds that develop between suppliers and clients. Fourth is the emergence of an overall community coordinating body.

ORGANIZATION UNDER STRESS

by

E.L. Quarantelli

The speaker describes the relations existing in time of stress between four types of organizations: Type I (an established group carrying out regular tasks) would be exemplified by the official members of a city police force directing traffic after a tornado has struck a community. Type II (an emergent group with regular tasks) would be illustrated by Red Cross volunteers running a shelter after a hurricane. As for Type III (an established group undertaking non-regular tasks), an example of it would be a home construction company utilizing its men and equipment for digging through debris in the rescue work undertaken after a major explosion. Type IV (an emergent group engaged in non-regular tasks) would be represented by an *ad hoc* group made up of the City Engineer, County CD director, the local representative of the State Highway Department, and a Corps of Engineer Colonel, coordinating over-all community responses during a flood.

Recalling that Type I and Type II organizations are rather well known because of their pre- and post-disaster existence, he urges that more attention be given to the knowledge and planning of Types III and IV groups.

The text of the article may be found in:

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1966)
R.C. Brieton ed.

ADEQUACY AND INADEQUACY OF DISASTER PLANS AND PREPARATIONS

by A.L. Parr

Introduction

It is rare to find an American community today with a complete lack of disaster plans and preparations. However, when disaster strikes, many communities find that their plans and preparations are insufficient and in need of improvement. When community organizations have no practiced preparations which fit into an organized, overall disaster plan, response to the disaster tends to be too segmental, too limited in scope, and too much dominated by immediate tasks to provide efficiently for the more general, continuing human needs posed by a disaster.

It is the purpose of this brief paper to report findings about the adequacy and inadequacy of disaster plans and preparations in ten community crises in the United States. The ten cases have been selected from those studied by the Disaster Research Center (DRC) and include the following: (1) 1963 Indianapolis, Indiana Coliseum explosion, (2) 1964 Anchorage, Alaska earthquake, (3) 1964 Cincinnati, Ohio flood, (4) Wichita, Kansas plane crash, (5) 1966 Topeka, Kansas tornado, (6) 1967 Fairbanks, Alaska flood, (7) 1968 Jonesboro, Arkansas tornado, (8) 1969 Glendora, California flood and mudslides, (9) 1969 Sioux Falls, South Dakota flood, and (10) 1969 Minot, North Dakota flood. These disasters range from a progressive, diffused type, the Fairbanks flood, to an instantaneous, localized type, the Wichita plane crash. Our goal is to provide the disaster planner with findings that can be applied in formulating approaches to alleviate disaster disruptions. Given the high degree of similarity between American and Canadian societies, it is anticipated that the findings from these ten American community crises will be of assistance and interest to Canadians involved in disaster planning.

The Findings

Our focus is upon the social-organizational rather than the physical or engineering aspects of disaster planning. We shall deal with disaster plans in terms of assessment of the crisis situation, communication possibility, community authority structure, interorganizational co-ordination, and general weaknesses of disaster plans.

Assessment of the Crisis Situation

In many communities the disaster plans do not assign an official or organization with the responsibility of assessing the situation to find out just what the overall emergency is and what it means. The typical response is for each organization to appraise the situation in terms of its own functions and needs, and then to retain the disaster information within the organization rather than sharing or pooling the knowledge on a community-wide basis. Disaster preparations seldom provide for systematic reconnaissance and other procedures for maintaining a central strategic overview of the crisis.

In Indianapolis, Anchorage, Fairbanks, Jonesboro, Glendora, and Minot the nature and extent of the damage to the community was not ascertained for a considerable period of time after disaster impact. However, this information was crucial and necessary in order to understand the overall dimensions of the tasks now facing the community. In contrast, disaster planning was more extensive in Cincinnati, Wichita, Topeka, and Sioux Falls and in these disasters knowledge about the number of dead and injured, the areas that were damaged, and the nature of the damage was more readily available.

Communication Possibility

The disaster preparations of a community frequently do not make any arrangements for emergency communications, and regular communication facilities are often inadequate or inoperative during a crisis. A large part of the disorganization which follows a disaster stems from the fact that normal methods of communication are often disrupted while the necessity for communication is increased. In addition, few disaster plans make any arrangements for disseminating disaster information to the community organizations, mass media, and general public. As a result varying and conflicting reports of the disaster sometimes arise and receive wide coverage through mass communication. Thus, two major types of communication problems arise in crises: (1) a lack of alternative means of communication, and (2) inaccurate communication content.

In Anchorage, Fairbanks, and Minot damage to telephone facilities and a lack of sufficient radio communication facilities resulted in inadequate communication during the crises. In comparison, the fire and police department radio communication facilities in Topeka and Sioux Falls were capable of handling a large volume of emergency communication, and in these two disasters, communication problems were minimal.

Inaccurate communication about the flood crisis did not occur in Sioux Falls as it did in Fairbanks, Glendora, and Minot. The disaster plans of Sioux Falls specified that a daily briefing should be held for all organizational officials and anyone else seeking disaster information. Such a briefing took place daily at the emergency operations center, and, in addition, all news releases were made by only two officials, the co-ordinator or assistant co-ordinator of flood activities. In contrast, the disaster plans in Fairbanks, Glendora, and Minot did not make provisions for such communication possibility.

Community Authority Structure

Authority procedures are not always apparent once a community has been struck by disaster. When authority is not operative, the response of community organizations frequently occurs outside a chain of command. In situations where overall control is lacking, the occurrence of disputes concerning authority, responsibilities, and jurisdictions is not uncommon.

Disaster plans sometimes fail to designate a legitimate source of overall control of emergency activities, and they thus contribute to a community authority vacuum or ambiguity concerning which official, agency, or organization has the authority to make crucial decisions during a crisis. This was the case in Indianapolis, Fairbanks, Jonesboro, and Minot. For example, the disaster plan in Indianapolis specified that civil defense should assume overall control when a state of emergency is declared, but it did not make explicit a source of authority in a situation such as the Coliseum emplosion where no state of emergency was declared. The disaster plan in Sioux Falls, by way of contrast, indicated four alternative sources of authority: (1) mayor, (2) civil defense co-ordinator, (3) flood-control project superintendent, and (4) a long-time employee of the city light department. With this explicit definition of the chain of command, there was no ambiguity or lack of authority at any time during the flood crisis.

Few disaster plans make arrangements for the establishing of command posts at the disaster scene. Consequently, members of organizations involved in the disaster response have no one person or no central location in the field to turn to for advice and direction. This was the situation that developed in Indianapolis, Fairbanks, Jonesboro, Glendora, and Minot. In these disasters, officials of high rank and authority in the predisaster stage failed to set up command posts and exercise authority and leadership in the disaster system. Rather, they became directly involved in such activities as search and rescue, transportation of casualties, and traffic direction. In contrast, in Wichita and Topeka high-ranking organizational officials immediately set up command posts at the disaster sites, and thus insured overall control and command of disaster operations.

Interorganizational Co-ordination

Most of the problems of disaster originate in the lack of co-ordination among the many groups and organizations, each of which is viewing and attempting to meet the needs of the disaster in terms of its own perspective and capabilities. The immediate problem in a disaster situation is neither uncontrolled behavior such as looting nor intense emotional reaction such as panic, but deficiencies of interorganizational co-ordination. It is often the case that allocation of resources is decentralized to a large number of organizations, each under pressure to act quickly and directly, and little or no attention is given to the linking of these resources by spanning the boundaries of the organizations. Most organizations involved in large-scale disasters lack predisaster understanding as to the scope of their activities and the necessity of co-ordinating their activities with one another. Specific organizations show some hesitancy in seeking co-ordination with others or assuming the responsibility themselves since it is seldom seen as being an inherent or traditional function of any one community organization.

Some disaster plans facilitate interorganizational co-ordination by arranging for the activation of an emergency operations center during a time of crisis. The plans frequently call for a representative from each key emergency organization to function from the center or at least for organizational representatives to attend community-wide meetings at the center. At these meetings representatives from the various involved organizations usually present reports of their respective activities. Through these reports each organization becomes aware of what other organizations are accomplishing, and consequently omission or needless duplication of crucial tasks is minimized. Problems arising during daily operations are considered at the meetings and generally through discussion a consensus is reached resolving the problem. Plans of action are frequently discussed and formulated.

In Cincinnati, Topeka, and Sioux Falls preplanning for an emergency operations center had been undertaken, and in these communities, these centers became functional and there was overall co-ordination and direction of organizational efforts throughout the crisis. In a number of the other disasters, Anchorage, Fairbanks, Jonesboro, Glendora, and Minot, a centralized, co-ordinating center did not exist at the beginning of the disaster primarily because of the lack of adequate and up-to-date preplanning. Thus, in the early stage of these crises, there was organizational atomization of the emergency response with community organizations carrying on their disaster activities independently of each other.

Some General Weaknesses of Disaster Plans

Disaster frequently creates new tasks of undeniable immediacy which must be accomplished if the community is to continue to exist and function as a viable entity. These tasks are seldom anticipated and considered in disaster plans, and thus there is usually no prior assignment of organizational responsibility. For example, search-and-rescue activity is not often considered the major responsibility of any existing community organization. The task of information clearance is one which is usually not previously routinized within a community and often several organizations assume this task with conflict and confusion ensuing. Other disaster-generated tasks that are commonly unassigned include inventory of existing resources such as available food and fuel supplies after disaster impact, feeding and sheltering of refugees, issuing of access passes to the disaster area, control of vehicle and pedestrian convergence, effective use of volunteers in ongoing operations, and transportation and feeding of volunteers and disaster workers. In order to have an agreed upon, understood division of labor among different groups and organizations in disaster, disaster plans should take into account and assign the tasks that commonly occur in community crises.

Many communities prepare for a specific type of disaster such as a nuclear catastrophe when drawing up disaster plans, and preparations for natural disasters and other peacetime crises are often neglected. Consequently, when disaster strikes, the existing disaster plans may be inappropriate. This was the case in both Anchorage and Minot where the disaster plans and preparations were oriented toward a nuclear explosion, and could not be easily adapted to the earthquake and flood crises.

Disaster plans also frequently remain in the "paper" stage and are not rehearsed in simulation exercises. Through lack of practice, gaps in the plans and ineffective aspects in disaster preparations remain undetected. These quickly appear in the time of disaster and crucial time must be taken to make compensations for the inadequate "paper" arrangements. When there is a lack of rehearsals, there is also a general lack of familiarity with existing disaster plans and preparations, and yet effective plans must be understood and accepted by all those who have a part in them, including the general public. In Topeka, for example, yearly disaster simulations are held to coincide with the beginning of the tornado season, and in this community the disaster plans were very effective during the tornado crises.

To be effective disaster plans must be subjected to regular review and revision. All plans have to be up-to-date to be of optimum use and value in coping with a crisis.

It is not unusual for disaster plans to be of limited value during a crisis because they have not been given any attention since the time they were first formulated. This situation existed in Indianapolis and Jonesboro where disaster plans and preparations had been neglected for a period of years, and as a result lists of available equipment and names and phone numbers were outdated.

Finally some disaster plans stress the physical aspects of disasters and pay insufficient attention to the social-organizational aspects of disaster response. For example, in Glendora, in preparation for flooding, sandbags had been stored in accessible locations and dykes and plywood barriers had been erected throughout the community. However, the plans and preparations were not adequate since no arrangements had been made for overall co-ordination of these disaster activities and for interorganizational communications. The scope of disaster plans should be sufficiently broad to encompass the social-organizational as well as the physical contingencies of disasters.

Conclusion

We have through the consideration of ten disasters studied by the Disaster Research Center attempted to identify some of the recurrent problems in disaster planning. Our underlying assumption has been that knowledge of what actually happens during disaster response is requisite for effective planning for community disasters.

The findings bear testimony to the need for large-scale disaster planning, and at the same time they should contribute to a more satisfactory basis for such planning. In other words, we hope the findings by pointing out the adequacy and inadequacy of some existing plans suggest directions that community leaders may take in planning to meet disasters effectively.

It is further hoped that the findings will contribute information and offer guidance to increase the efficiency of efforts to minimize destruction and to restore necessary facilities in disaster areas, and thus make a contribution to national survival in the event of a nuclear war. We have not, however, endeavoured to extrapolate our findings to thermonuclear situations. Perhaps after further study of peacetime disasters attempts can be undertaken to extrapolate findings from completed disaster studies to a kind of disaster that is difficult to envisage.

CCMS No. 9

ORGANIZATIONAL PROBLEMS IN DISASTERS

by E.L. Quarantelli

The Disaster Research Center, the only one of its kind in the world, was established at The Ohio State University in 1963. The Center is engaged in a variety of sociological research studies on the reactions of groups and organizations in community-wide emergencies, particularly natural disasters and civil disturbances. Since its inception, 122 different field studies have been carried out. Teams have gone to earthquakes (in Japan, Alaska, Chile, Yugoslavia, Iran, El Salvador and Greece), hurricanes (in Florida, Texas, Mississippi and Louisiana), floods (in Italy, Canada, Iowa, Montana, Texas, Alaska, Colorado, Virginia, California, Minnesota and the Dakotas), as well as tornadoes (in Arkansas, Indiana, Mississippi, Iowa and Kansas). Large explosions and fires toxic incidents, destructive seismic waves and major dam breaks have also been studied in Australia, Italy, Canada and different sections of the United States. Center personnel have examined civil disturbances in Cincinnati, Los Angeles, Detroit and Indianapolis as well as elsewhere and are conducting special studies of legal aspects of disasters, cross-cultural responses to catastrophes and diffuse emergencies such as water pollution.

The Center has 19 professionals on its staff plus supporting clerical and secretarial personnel. It is headed by Professors Russell R. Dynes and E. L. Quarantelli, both members of the Department of Sociology in the University.

Field research teams ranging in size from two to five researchers are prepared to leave for any community emergency on two-hours notice. Longer range research focused on emergency-induced community change is conducted as well as immediate on-the-spot studies. Alaska, New Orleans, Topeka and Indianapolis were restudied several years after major emergencies. In addition, sixteen cities around the country ranging from Brownsville, Texas and Buffalo, New York to Los Angeles, California and Miami, Florida are regularly monitored for community crises.

A laboratory equipped with audio and visual devices is the locale of a supplementary part of the research program. In this laboratory, simulated conditions are created to parallel real-life stress on social processes. This research has ranged from the study of the communication behavior of police dispatching units to an examination of cross-cultural interaction.

Together, the laboratory and the field operations are intended to provide basic knowledge about group behavior and social life as well as information which can be used to develop more effective plans for future emergencies. Besides collecting its own data, the Center also serves as a repository for documents and materials collected in previous research by other agencies and researchers. The Center's research library is open to all interested scholars and public and private agencies which cope with disaster problems. The Center has its own monograph series and also publishes a quarterly newsletter, Unscheduled Events, available upon request.

Support for the Center comes from diverse sources including the National Institute of Mental Health Center for Applied Social Problems, the U.S. Office of Civil Defense, the Department of the Interior, the Air Force Office of Scientific Research as well as other state and federal agencies, and from the University including the Mershon Social Science Program.

Today I want to talk about our studies on natural disasters, particularly on our findings from research sponsored by the Office of Civil Defense (O.C.D.). The Office of Civil Defense was one of our two earliest supporters and has contributed substantially to the Center's success. While OCD has had different interests at different times, we will today be making a general overall report, rather than talking about specific research projects.

The Role of Civil Defense in Disasters

At The Ohio State University Disaster Research Center, we have made more than 75 field studies of different community disasters. In these studies we have had the opportunity to see civil defense operations in a wide variety of contexts. One observation about civil defense stands out -- either civil defense is highly regarded, frequently consulted, and plays a major role in everything from minor crises to large-scale, community wide disasters, or civil defense is regarded in just the opposite way. In some communities it is very unfavorably viewed, seldom consulted in emergency planning and almost totally ignored when actual disasters occur. It is almost a dichotomy, either/or -- either civil defense is central to emergency responses or it plays no real part at all. Why? What accounts for the difference?

It is not the legal position of civil defense that makes it an important element or not important. Legally, practically everywhere in the United States, civil defense is supposed to play a major role at time of disaster, but whether it plays a key role or not is dependent on something other than its legal position. At times the law is blithly and totally ignored, at other times civil defense is far more central in an emergency response than the law either requires or demands.

Two factors at least seem to determine the acceptability and actual responsibility given to civil defense. One is what civil defense has contributed in prior disasters -- or more accurately, emergencies -- in the community. If civil defense has shown value in an earlier community crisis, other community agencies, officials and groups will turn to it in a new emergency. Geographic areas subject to predictable and regular disasters tend to have respected and viable civil defense groups. Their contributions and operations in past disasters gives them a powerful leverage in disaster planning and makes them listened to when a new emergency occurs.

There is, however, another way by which civil defense can establish and legitimatize itself in a community. This is to provide well thought out and overall disaster plans. But disaster planning requires knowledge and it requires knowledge of the problems that are actually likely to occur in a major emergency. But it is actually such knowledge that is normally in short supply in communities not subject regularly to disasters.

If you are interested in developing emergency planning, let me suggest some guidelines based on experience of what realistically are and are not problems in community disasters. Before getting into any details, let me indicate my starting point.

Disaster or Emergency Planning

It is that the efficiency and effectiveness of a community response to a disaster is dependent on the integration and coordination of the organizations in the area. This is not just simply paying lip service to the value placed on local autonomy of community organizations. It is a fact of life that the speed of recovery, the solving of problems and all aspects of a disaster are dependent on the response of the local community organizations. While much assistance and help may be brought in from outside the community, it is the local groups that will affect if and how such outside assistance is obtained and utilized. Only in very devastating disasters where the personnel of local organizations might be literally obliterated, would non-local groups become the key groups.

Now in disaster planning or emergency planning, where it is assumed local organizations will be the key units, there are three different aspects that have to be taken into account.

1. The victim population. What can disaster planning assume and not assume about the victims or the impacted population, the community residents or whatever you want to call the general populace that will be involved? As I shall indicate in just a little while, there are certain myths about the responses of people to disasters. These myths, if accepted as being true, can make a hash of disaster planning and good organizational response.

2. The community organizations themselves. What should disaster planning focus on -- and given the composition of this audience -- where might civil defense best fit in? As I shall discuss soon, different types of organizations respond in different ways to disasters and it is crucial to take such differences into account in planning.

3. Finally, while local community organizations are the keystone to emergency responses in American society, in any but the most minor of disasters, outside help and assistance of some kind will be needed. Local organizations, especially any coordinating group can only operate effectively if they know probable points of difficulty and frictions in the contact between local and non-local organizations.

Obviously, if I went into details on even just one of these aspects, I would take up all the rest of the day. I will have to be very selective in my remarks and hit on what I consider the most important points for disaster planning.

Let me restate again that my remarks are based on a large number of observations of different organizations in many disasters in different parts of the country. Each disaster has its unique aspects, but there are common elements and these are the only things upon which planning can be based. The things I will mention are those features that are most probable, those that typically can be seen in disaster after disaster. You might, on the base of an experience here or there, think of an exception to the patterns I shall depict. But exceptions should not blind one to typical and probable patterns. In planning one has to plan on the likelihood of probabilities, not the exceptional, the rare or the unusual instance.

Myths About Disaster Responses

I made reference to myths earlier when talking of how individuals, the victim population, react. Let me mention three of them and suggest some implications for organization response and disaster planning.

1. The "Panic" myth. This is one that is deeply entrenched in the thinking of many people and is constantly reinforced by journalists, mass media presentations and literary accounts. It is thought that groups and persons will engage in many irrational acts, make illogical decisions and show a strong anti-social disregard for others in the crisis situation. The "Panic" myth implies the general expectation of rather widespread chaos and pandemonium, at both the individual and group level. The scene is visualized in terms of hysteria, irrationality, dis-organization and disorder. If you think I have overdrawn the "Panic" myth, I assure you that I could strongly document it. Not only would it be easy to document the fact that the "Panic" image exists, but more important, that responsible officials often act as if it were a correct picture of what occurs in disasters. You can find situations where persons in positions of responsibility did not evacuate an area because they were afraid of setting off a wild, hysterical flight; further more, time, energy and resources are spent planning on how to prevent such reactions. The "Panic" myth not only exists but is often the basis for action.

   This at times leads to cruel dilemmas for key officials and others who have to make important decisions during emergencies. For instance, an official may feel that if he issues an evacuation warning, he will generate a panic flight. On the other hand, the official may be haunted by the possibility that if no action is taken to get people to leave, these persons may become the victims of a threatening danger. Either way the decision is a difficult one if the "Panic" myth dominates official thinking.

   However, available research evidence suggests that most anticipated "Panic" behaviors are not too likely. People seldom flee wildly. In fact, the opposite is more of a problem, that of getting people to leave their homes or neighborhoods, even when danger is visible. This was true for example in Hurricane Camille.

   For reasons we can not detail here, people in general can be expected to react rather well, rather rationally and with astounding little disorder and disorganization. Actually in the face of direct threat, people more often than in normal times, are careful about their behavior and attempt to think through the consequences of their acts. Action is far less impulsive than in everyday life, for when people feel their lives, those of loved ones or their property is in danger, they become cautious and careful.

   It is true that, during times of stress, isolated cases of erratic or seemingly illogical behavior can be found. However, the overall picture is one of remarkable rationality and order. In general, it can be said that most human beings act in quite controlled and adaptive ways in the face of the new and extreme stresses which they face during a large scale disaster. The atypical case, which is the delight of newspapermen, should not be confused with the average response, which is, primarily, what responsible organizational officials have to deal with in emergencies.

2. The "looting" myth. This notion seems to be even more deeply ingrained in the thinking of people and appears to be based on a Jekyll and Hyde conception of human beings. If you don't watch them or in a confused situation, human beings will break loose. Thus, it is believed looting is widespread in disasters.

The fact of the matter is just the opposite; looting is extremely rare -- almost totally non-existent by residents of the area. Reports of looting are widespread. However, actual arrest and report figures show crime rates drop. Such rare looting as occurs tends to take place after the immediate emergency period and it is undertaken by non-local people. To put it bluntly, such evidence as there is suggests the minor looting that ensues often takes place by non-local security forces brought in mistakenly to prevent it. It is not accidental that this was one of the major reports that came out of the Gulf coast after Hurricane Camille.

In most disasters, security measures are really very loose -- even a day or two later it is remarkably easy to bypass security. Yet even in situations of little or no security, there still is no looting. Most of this is due to the development of a community consensus, which we have discussed in detail elsewhere.

I do not want to imply total disregard of security. Some is needed if for no other reason than the symbolism involved; also, it is needed in later stages of emergency period although use is mostly in traffic control. The point I am making is the need to keep a balanced view on this matter. There is a tendency to use resources and personnel on this matter that could be better used on other tasks.

3. The "passivity" image or what I sometimes call the "Big Brother" image. There is a widespread notion that disaster victims are passive and docile, that they are devoid of initiative and that they have to have everything done for them by others, especially by organized groups. The picture basically is one of impotent individuals waiting almost childishly for someone to take care of them. Hence, the label "Big Brother," for the general expectation is that disaster victims are apathetically dependent on "Big Brother" in the form of relief and rehabilitation workers.

Again, it might be felt that the picture is overdrawn. However, once more, it would be easy to document the fact that this image guides the thinking and planning of many disaster organizations and their personnel. Time, money, manpower and other resources are directed towards dealing with problems implied by the 'Big Brother' image. For instance, exhaustive efforts are frequently made to provide emergency mass housing (which in this country is almost never used by disaster victims), while other more crucial problems are largely ignored such as the need for a centralized clearing house of information regarding whereabouts and conditions of evacuated victims.

As in the instance of the "Panic" myth, the "Big Brother" image is also incorrect. However, in no sense is this to be taken as in any way questioning the absolute need for organizational activities in disasters or the fact that such groups carry out many crucial emergency tasks. Instead, what I am trying to indicate here is that the actual problems of organizations reside elsewhere than in what the "Big Brother" image implies. The major difficulties that organizations typically have in major catastrophes are in other areas, and planning should be directed in those directions. If efforts and resources are to be most effectively utilized, they have to be used in connection with actual and not mythical difficulties.

What do we at the DRC see as the real and major problem areas for organizations in disasters? As far as we can tell, they revolve around matters of communication, authority and coordination. This is not to say that there are problems in these areas alone. However, if the difficulties that arise in such matters were resolved, few organizations would have serious troubles in responding to community-wide emergencies.

Communications

First of all, let me discuss communication matters. In some rare instances, communication problems stem from equipment scarcity, emerge from damaged facilities or from other destruction of the physical means of communicating. However, in the vast number of cases, the problems are not in the mechanisms but in the process itself. That is, the physical means for communications will be present, but they will not be used in the most appropriate way or will not be employed at all. Thus, difficulties in communication are more often the result of social or group malfunctionings, rather than the consequence of engineering or technical breakdowns.

It is possible to see communication difficulties as existing in one of four different categories: (1) within individual organizations; (2) between organizations; (3) from organizations to the public; and (4) from the public to organizations.

First of all, organizations have to communicate internally; exchange of information has to go on among the members of the group. Normally, the communication system is geared to processing and exchanging a certain amount of information. However, in a disaster, you generally have an expansion of staff members of organizations. Double shifts may be employed or volunteers may be incorporated into the work force. The normal communication system often cannot take care of the additional load of information that has to be exchanged because of the added staff. In a sense, the extra demands upon the internal communication system will frequently exceed the capabilities available, with consequent retardation if not loss of information flow among staff members.

Normally, too, communications are supposed to go through certain channels.

In non-crisis situations, the lines of communication from the top to the bottom in the chain of command and from the bottom to the top, are relatively clear-cut, so that it is fairly obvious who is supposed to get what information as well as where and when the information is to be exchanged. However, during an emergency you may get two, three or even four occupants in the same position normally occupied by one person. Officials may also take over jobs they do not routinely undertake, or they may work at emergency positions in the organizational structure. Consequently, the normal channels of communication are usually not sufficient to insure that all relevant information will circulate to and from those persons in the group who should be informed of organizational activities.

Difficulties may develop along a second dimension, that of communication between organizations. The reason for potential problems here appears to be twofold. In normal, everyday, routine contact between organizations, much of the interaction proceeds on an informal basis. Officials will often be talking with known persons, if not friends. When a disaster occurs and there are changes in the organizational structure, the informal basis of communication may not suffice. Contacts may have to be established and maintained with unfamiliar individuals occupying official positions in other organizations.

Furthermore, community emergencies typically precipitate relationships between organizations not normally in contact with one another, so that groups have to forge new links with previously unrelated organizations and develop contacts they have not had before the disaster. This is difficult to do, particularly under the pressures of a disaster situation. Communications between organizations will frequently not proceed smoothly under such circumstances.

A third category in which problems may arise, is in communication from organization to the general public. One major source of difficulty here is that what is meaningful information to organizational personnel often may not mean much to people in general. This stems from the fact that an official group will frequently gather detailed information about what is going on, and obtain a general picture of the overall situation. On the basis of that information, the organization will issue some advice, some instruction to the general public which, however, will omit or ignore in the announcement the background and general picture known to group officials. For instance, an announcement will be made to people to leave a danger area. That will be the sum total of the statement: "evacuate X street or Y neighborhood." The officials issuing the statement may know quite well the limits of the endangered zones, and the degree of safety likely in different places, but none of this will appear in the announcement. Thus, the warned population is forced into the position of trying to ascertain which are and which are not the danger areas, and where it might be safe to evacuate. Too often organizations which are well informed about emergency events and possibilities will assume that their public statements will be as clear to everyone as they are to themselves.

The final category in which there may be difficulties is communication from the public to the different organizations. There seem to be several aspects to this. After a disaster, but in some situations even prior to its actual occurrence, people will bombard organizations with requests for aid and information. They will ask the more visible kinds of public groups what should be done, where certain things can be obtained, and so forth. A frequent result of this is that the organizational system for processing information will not function as it should.

The effect of the flood of telephone calls to police departments or hospitals during emergencies in a community is typical. The police or hospital switchboard becomes so overloaded with calls that all communication, in or out of the organization, is interminably delayed.

Organizations also find themselves often subject to all sorts of new kinds of requests in addition to being overloaded with requests for normal kinds of aid and information. Groups will be asked about things which they never or very infrequently are asked about. Few organizations are prepared to deal with non-routine questions: persons who man switchboards or complaint desks thus often find themselves unable to adapt to the new kind of questions.

Generally, problems in the area of communication are the most serious ones. If difficulties in this area are not solved, there is no great need to worry about other kinds of problems. Rapid and accurate communications are the core of any effective organizational response to emergencies; without communications other problems cannot be solved.

Authority

Somewhat more briefly now I want to discuss matters regarding lines of authority. This is the second major problem area for organizations operating in disaster situations. However, certain anticipated troubles along this line are rare.

There are seldom any difficulties in maintaining authority within established groups. In fact, I cannot think of a single case which could be used to illustrate a traditional organization's loss of formal control over its own personnel. This does not seem to occur, or if it does, it occurs in so minor a degree that it is of no practical consequence.

Neither are there many problems that arise from questions concerning which organizations have authority and responsibility for traditional tasks. For example, there is never any dispute or conflict over who fights fires, repairs telephones, or over other tasks of that kind. Such matters are traditional responsibilities of certain community groups.

However, problems of authority during disasters do occur with respect to two other matters. Often there are difficulties between organizations regarding which group is responsible for new tasks created by a disaster. For instance, who is responsible for and has authority with regard to search and rescue activities? This is frequently a problem of major magnitude in many community emergencies.

Also, authority problems sometimes arise between emergent groups and more traditional organizations with respect to old tasks. For instance, since security of an area is considered a traditional police function, few difficulties arise in developing a pass system in conjunction with such groups as the National Guard or Federal troops. However, it sometimes happens that police and a new city agency or perhaps even civil defense will not fully agree on a pass system. The traditional organization sees certain activities as its responsibility alone, and disputes will occur if new groups are thought to be attempting to take over an old task such as that of maintaining security within an area. Many of the difficulties surrounding pass systems (and they typically arise in disaster situations) revolve around the issue of who has the authority, the traditional and established organizations or the emergent or newly created groups in the community?

While problems of authority are generally less serious in consequence than problems in the communication area, they are often more difficult to solve. In part, this is so because the question of organizational authority involves the whole fabric of formal and informal power in a community. This is a delicate and sensitive matter and full of pitfalls for anyone unsophisticated as to the structure and functioning of groups. Therefore, it is not surprising that authority problems are difficult to plan for, and equally hard to handle when they do arise in emergency situations.

Coordination

I now want to make a very few remarks about the third major problem area which the DRC has explored. I refer to problems having to do with coordination and decision-making. There seems to be at least three different aspects of this matter.

For one, organizations frequently have a great deal of difficulty in coordinating the activities of their volunteers. Unless many preparations have been made beforehand, innumerable difficulties arise as to what, where and how volunteers are to be used. Furthermore, most groups find it difficult to mesh the work of volunteers with the regular tasks of their usual labor force.

It is not even easy to plan for volunteers. Whatever planning is undertaken, it can rarely fully prepare for the quantity and quality of volunteers that appear. In other words, it is very difficult to anticipate how many and what kinds of people will volunteer their services to organizations during a community emergency.

Coordination between organizations working on common but new tasks is also difficult. Even groups that are used to working together, such as police and fire departments, may have problems when they try to integrate their activities in a novel task, such as search and rescue. While policemen and firemen may be used to looking through a building or two, in the instance of a major disaster, having to search whole neighborhoods, poses new problems of coordination and decision-making between the two organizations even though they have worked together before.

Finally, I want to note that there are problems arising from matters having to do with overall coordination and decision-making. This is not only an important matter, but is probably the most difficult problem to handle. It is an area in which there almost inevitably there are some difficulties.

Some of the problem stems from the fact that in the typical disaster, at least four different types of groups get involved. But their very involvement creates coordination problems. In some cases, difficulties in coordinating every group helping in the emergency can be more of a problem than the actual disaster itself.

What are the groups that get involved? They are:

1. The regular community emergency groups. They include such organizations

as the police and fire departments, hospitals, utilities, etc. In general, they stick to their traditional or regular tasks, and if they do that, they have relatively few problems.

2. Standby emergency groups. They are illustrated by such groups as the Red Cross and the Salvation Army. These are organizations that in normal times have certain non-disaster tasks that are carried out by a small core of professional staff personnel. At the time of a disaster, however, these groups not only expand tremendously through the taking on of volunteers, but they undertake new, emergency tasks or functions that are often quite different from their regular, daily, non-disaster tasks.

3. Voluntary associations such as service clubs, contractors, Boy Scouts and similar groups. They have no everyday emergency structures, tasks or responsibilities. But during an emergency they tend to take on in a very selective fashion, new structures and new tasks in connection with the disaster.

4. Coordinating groups. The activities during a disaster of a number of the three just mentioned groups, agencies and organizations creates the need for coordination of their activities. The consequences is the appearance -- by plan in some cases, by accident in most instances -- of a coordinating group. This emergent group attempts to bring about overall coordination in the various community responses to the disaster.

Since civil defense -- by design or by accident -- frequently plays some role in coordination of this nature, we want now to consider more specifically the operation of civil defense in major community emergencies. At the local community level, we may ask what is civil defense, what is its perceived role in disasters, and what are some of its problems? These and related matters will be discussed in the paper to be presented by Prof. Dynes.